

## APPENDIX G

### NEUTRON CROSS-SECTION LIBRARIES

This appendix is divided into five sections. Section I lists some of the more frequently used ENDF/B reaction types that can be used with the FMn input card. TABLE G-1 in Section II lists the currently available  $S(\alpha, \beta)$  data available for use with the MTm card. Section III provides a brief description of the available continuous-energy and discrete neutron data libraries. TABLE G-2 in Section III is a list of the continuous-energy and discrete neutron data libraries maintained by X-5. Section IV describes the multigroup data library MGXSNP (TABLE G-3), and Section V describes the dosimetry data libraries (TABLE G-4).

#### **I. ENDF/B REACTION TYPES**

The following partial list includes some of the more useful reactions for use with the FMn input card and with the cross-section plotter (see pages 3-87 and B-10.) The complete ENDF/B list can be found in the ENDF/B manual.<sup>1</sup> The MT column lists the ENDF/B reaction number. The FM column lists special MCNP reaction numbers that can be used with the FM card and cross-section plotter.

Generally only a subset of reactions are available for a particular nuclide. Some reaction data are eliminated by MCNP in cross-section processing if they are not required by the problem. Examples are photon production in a MODE N problem, or certain reaction cross sections not requested on an FM card. FM numbers should be used when available, rather than MT numbers. If an MT number is requested, the equivalent FM number will be displayed on the legend of cross-section plots.

Neutron Continuous-energy and Discrete:

<u>MT</u>	<u>FM</u>	<u>Microscopic Cross-Section Description</u>
1	-1	Total (see note 1 following)
2	-3	Elastic (see note 1 following)
16		(n,2n)
17		(n,3n)
18		Total fission (n,fx) if and only if MT=18 is used to specify fission in the original evaluation.
	-6	Total fission cross section. (equal to MT=18 if MT=18 exists; otherwise equal to the sum of MTs 19, 20, 21, and 38.)
19		(n,f)
20		(n,n'f)
21		(n,2nf)
22		(n,n'α)

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28		(n,n'p)
32		(n,n'd)
33		(n,n't)
38		(n,3nf)
51		(n,n') to 1 <sup>st</sup> excited state
52		(n,n') to 2 <sup>nd</sup> excited state
.		.
90		(n,n') to 40 <sup>th</sup> excited state
91		(n,n') to continuum
101	-2	Absorption: sum of MT=102-117 (neutron disappearance; does not include fission)
102		(n, $\gamma$ )
103		(n,p)
104		(n,d)
105		(n,t)
106		(n, <sup>3</sup> He)
107		(n, $\alpha$ )

In addition, the following special reactions are available for many nuclides:

202	-5	total photon production
203		total proton production (see note 3 following)
204		total deuterium production (see note 3 following)
205		total tritium production (see note 3 following)
206		total <sup>3</sup> He production (see note 3 following)
207		total alpha production (see note 3 following)
301	-4	average heating numbers (MeV/collision)
	-7	nubar (prompt or total)
	-8	fission Q (in print table 98, but not plots)

S( $\alpha, \beta$ ):

<u>MT</u>	<u>FM</u>	<u>Microscopic Cross-Section Description</u>
1		Total cross section
2		Elastic scattering cross-section
4		Inelastic scattering cross-section

Neutron and Photon Multigroup:

<u>MT</u>	<u>FM</u>	<u>Microscopic Cross-Section Description</u>
1	-1	Total cross section
18	-2	Fission cross section

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**ENDF/B REACTION TYPES**

	-3	Nubar data
	-4	Fission chi data
101	-5	Absorption cross section
	-6	Stopping powers
	-7	Momentum transfers
n		Edit reaction n
202		Photon production
301		Heating number
318		Fission Q
401		Heating number times total cross section

Photons (see note 4 following):

<u>MT</u>	<u>FM</u>	<u>Microscopic Cross-Section Description</u>
501	-5	Total
504	-1	Incoherent (Compton + Form Factor)
502	-2	Coherent (Thomson + Form Factor)
522	-3	Photoelectric with fluorescence
516	-4	Pair production
301	-6	Heating number

Electrons (see note 5 following):

<u>MT</u>	<u>FM</u>	<u>Microscopic Cross-Section Description</u>
	1	de/dx electron collision stopping power
	2	de/dx electron radiative stopping power
	3	de/dx total electron stopping power
	4	electron range
	5	electron radiation yield
	6	relativistic $\beta^2$
	7	stopping power density correction
	8	ratio of rad/col stopping powers
	9	drange
	10	dyield
	11	rng array values
	12	qav array values
	13	ear array values

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### ENDF/B REACTION TYPES

Notes:

1. At the time they are loaded, the total and elastic cross sections from the data library are thermally adjusted by MCNP to the temperature of the problem, if that temperature is different from the temperature at which the cross-section set was processed (see page 2–29.) If different cells have different temperatures, the cross sections first are adjusted to zero degrees and adjusted again to the appropriate cell temperatures during transport. The cross-section plot will *never* display the *transport* adjustment. Therefore, for plotting, reactions 1 and –1 are equivalent and reactions 2 and –3 are equivalent. But for the FM card, reactions –1 and –3 will use the zero degree data and reactions 1 and 2 will use the transport-adjusted data.  
For example, if a library evaluated at 300° is used in a problem with cells at 400° and 500°, the cross-section plotter and MT=–1 and MT=–3 options on the FM card will use 0° data. The MT=1 and MT=2 options on the FM card will use 400° and 500° data.
2. The nomenclature between MCNP and ENDF/B is sometimes inconsistent in that MCNP often refers to the number of the reaction type as R whereas ENDF/B uses MT. They are one and the same, however. The problem arises because MCNP has an MT input card used for the  $S(\alpha,\beta)$  thermal treatment.
3. The user looking for total production of p, d, t,  $^3\text{He}$  and  $^4\text{He}$  should be warned that in some evaluations, such processes are represented using reactions with MT (or R) numbers other than the standard ones given in the above list. This is of particular importance with the so-called “pseudolevel” representation of certain reactions which take place in light isotopes. For example, the ENDF/B-V evaluation of carbon includes cross sections for the  $(n,n'3\alpha)$  reaction in MT = 52 to 58. The user interested in particle production from light isotopes should check for the existence of pseudolevels and thus possible deviations from the above standard reaction list.
4. There are two photon transport libraries maintained by X-5, MCPLIB and MCPLIB02.<sup>2,3</sup> The photon library MCPLIB provides data for transporting photons with energies from 1 keV to 100 MeV. The default photon library MCPLIB02 provides data up to 100 GeV. Photon transport data are not provided for  $Z > 94$ , and coupled neutron-photon problems cannot be run for these nuclides.
5. X-5 maintains one electron transport library, EL. The MT numbers used for xs plotting are taken from Print Table 85 columns and are not from ENDF.

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**S(a,b) DATA FOR USE WITH THE MTm CARD**

**II.  $S(\alpha,\beta)$  DATA FOR USE WITH THE MTm CARD**

**TABLE G-1**  
**Thermal  $S(\alpha,\beta)$  Cross-Section Libraries**

ZAID	Date of Processing	Material Description	Nuclides*	Temp (°K)
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THERXS1 (Source: LANL)

smeth.01t	04/10/88	Solid methane	1001	22
lmeth.01t	04/10/88	Liquid methane	1001	100
hpara.01t	03/03/89	Para H	1001	20
hortho.01t	03/03/89	Ortho H	1001	20
dpara.01t	05/30/89	Para D	1002	20
dortho.01t	05/30/89	Ortho D	1002	20

TMCCS1 (Source: ENDF)

lwtr.01t	10/22/85	H in light water	1001	300
lwtr.02t	10/22/85	H in light water	1001	400
lwtr.03t	10/22/85	H in light water	1001	500
lwtr.04t	10/22/85	H in light water	1001	600
lwtr.05t	10/22/85	H in light water	1001	800
poly.01t	10/22/85	H in polyethylene	1001	300
h/zr.01t	10/22/85	H in Zr-hydride	1001	300
h/zr.02t	10/22/85	H in Zr-hydride	1001	400
h/zr.04t	10/22/85	H in Zr-hydride	1001	600
h/zr.05t	10/22/85	H in Zr-hydride	1001	800
h/zr.06t	10/22/85	H in Zr-hydride	1001	1200
benz.01t	09/08/86	Benzene	1001, 6000, 6012	300
benz.02t	09/08/86	Benzene	1001, 6000, 6012	400
benz.03t	09/08/86	Benzene	1001, 6000, 6012	500
benz.04t	09/08/86	Benzene	1001, 6000, 6012	600
benz.05t	09/08/86	Benzene	1001, 6000, 6012	800
hwtr.01t	10/22/85	D in heavy water	1002	300
hwtr.02t	10/22/85	D in heavy water	1002	400
hwtr.03t	10/22/85	D in heavy water	1002	500
hwtr.04t	10/22/85	D in heavy water	1002	600
hwtr.05t	10/22/85	D in heavy water	1002	800

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**TABLE G-1 (Cont.)**  
**Thermal  $S(\alpha,\beta)$  Cross-Section Libraries**

<b>ZAID</b>	<b>Date of Processing</b>	<b>Material Description</b>	<b>Nuclides*</b>	<b>Temp (°K)</b>
be.01t	10/24/85	Be metal	4009	300
be.04t	10/24/85	Be metal	4009	600
be.05t	10/24/85	Be metal	4009	800
be.06t	10/24/85	Be metal	4009	1200
beo.01t	09/08/86	Be oxide	4009, 8016	300
beo.04t	09/08/86	Be oxide	4009, 8016	600
beo.05t	09/08/86	Be oxide	4009, 8016	800
beo.06t	09/08/86	Be oxide	4009, 8016	1200
grph.01t	09/08/86	Graphite	6000, 6012	300
grph.04t	09/08/86	Graphite	6000, 6012	600
grph.05t	09/08/86	Graphite	6000, 6012	800
grph.06t	09/08/86	Graphite	6000, 6012	1200
grph.07t	09/08/86	Graphite	6000, 6012	1600
grph.08t	09/08/86	Graphite	6000, 6012	2000
zr/h.01t	09/08/86	Zr in Zr-hydride	40000	300
zr/h.02t	09/08/86	Zr in Zr-hydride	40000	400
zr/h.04t	09/08/86	Zr in Zr-hydride	40000	600
zr/h.05t	09/08/86	Zr in Zr-hydride	40000	800
zr/h.06t	09/08/86	Zr in Zr-hydride	40000	1200

\*Nuclides for which the  $S(\alpha,\beta)$  data are valid. For example, lwtr.01t provides scattering data only for  $^1\text{H}$ ;  $^{16}\text{O}$  would still be represented by the default free-gas treatment.

### **III. MCNP NEUTRON CROSS-SECTION LIBRARIES**

TABLE G-2 lists all the continuous-energy and discrete neutron data libraries maintained by X-5. The entries in each of the columns of TABLE G-2 are described as follows:

ZAID – The nuclide identification number with the form ZZZAAA.nnX  
 where ZZZ is the atomic number,  
 AAA is the mass number (000 for naturally occurring elements),  
 nn is the neutron cross-section identifier  
 X=C for continuous-energy neutron tables  
 X=D for discrete-reaction tables

ATOMIC – The atomic weight ratio (AWR) is the ratio of the atomic mass of the

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**MCNP NEUTRON CROSS-SECTION LIBRARIES**

**WEIGHT –** nuclide to a neutron. This is the AWR that is contained in the original  
**RATIO –** evaluation and that was used in the NJOY processing of the evaluation.

**LIBRARY –** Name of the library that contains the data file for that ZAID. The number in brackets following a file name refers to one of the special notes at the end of TABLE G-2.

**SOURCE –** Indicates the originating evaluation for that data file.

ENDF/B-V.# or ENDF/B-VI.# ( such as B-V.0 and B-VI.1) are the Evaluated Nuclear Data Files, a US effort coordinated by the National Nuclear Data Center at Brookhaven National Laboratory. The evaluations are updated periodically by evaluators from all over the country, and the release number of the evaluation is given. This is not necessarily the same as the ENDF revision number for that evaluation. For example, Pu-242 is noted as ENDF/B-VI.2 as it is from release 2 of ENDF/B-VI, but it is revision 1 of that evaluation.

LLNL – evaluated nuclear data libraries compiled by the Nuclear Data Group at Lawrence Livermore National Laboratory. The number in the library name indicates the year the library was produced or received.

T-2 – evaluations from the Nuclear Theory and Applications group T-2 at Los Alamos National Laboratory.

—:T-2 or —:X-5 – indicates the original evaluation has been modified by the Los Alamos National Laboratory groups T-2 or X-5.

**DATE of - EVALUATION –** Denotes the year that the evaluation was completed or accepted. In cases where this information is not known, the date that data library was produced is given. If minor corrections were made to an evaluation, the original evaluation date was kept. The notation “<1985” means “before” 1985.

**TEMP –** Indicates the temperature (°K) at which the data were processed. The temperature enters into the processing of the evaluation into a data file only through the Doppler broadening of cross sections. The user must be aware that without the proper use of the TMP card, MCNP will attempt to correct the data libraries to the default 300°K by modifying the elastic and total cross sections only.

Doppler broadening refers to a change in cross section resulting from thermal motion (translation, rotation and vibration) of nuclei in a target material. Doppler broadening is done on all cross sections for incident neutrons (nonrelativistic energies) on a target at some temperature (TEMP) in which the free-atom approximation is valid. In

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general an increase in the temperature of the material containing neutron-absorbing nuclei in a homogeneous system results in Doppler broadening of resonances and an increase in resonance absorption. Furthermore, a constant cross section at zero °K goes to 1/v behavior as the temperature increases. You should not only use the best evaluations but also use evaluations that are at temperatures approximating the temperatures in your application.

- LENGTH – The total length of a particular cross-section file in words. It is understood that the actual storage requirement in an MCNP problem will often be less because certain data that are not needed for a problem may be expunged.
- NUMBER of – The number of energy points on the grid used for the neutron cross
- ENERGIES – section for that data file. In general, a finer energy grid (or greater number of points) indicates a more accurate representation of the cross sections, particularly through the resonance region.
- $E_{max}$  – The maximum incident neutron energy for that data file. For all incident neutron energies greater than  $E_{max}$ , MCNP assumes the last cross section value given.
- GPD – “yes” means that photon-production data are included;  
“no” means that such data are not included.
- $\bar{v}$  – for fissionable material,  $\bar{v}$  indicates the type of fission nu data available.  
“pr” means that only prompt nu data are given;  
“tot” means that only total nu data are given;  
“both” means that prompt and total nu are given.
- CP “yes” means that secondary charged-particles data are present;  
“no” means that such data are not present.
- DN “yes” means that delayed neutron data are present;  
“no” means that such data are not present.
- UR “yes” means that unresolved resonance data are present;  
“no” means that such data are not present.

TABLE G-2 contains no indication of a “recommended” library for each isotope. Because of the wide variety of applications, no one set is “best.” The default cross-section set for each isotope is determined by the XSDIR file being used (see page 2-21.)

Finally, you can introduce a cross-section library of your own by using the XS input card.

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**TABLE G-2**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
<b>Z = 1 ***** Hydrogen *****</b>													
** H-1 **													
1001.35c	0.9992	endl85	LLNL	<1985	0.0	3506	330	20.0	yes	no	no	no	no
1001.42c	0.9992	endl92	LLNL	<1992	300.0	1968	121	30.0	yes	no	no	no	no
1001.50c	0.9992	rmccs	B-V.0	1977	293.6	2766	244	20.0	yes	no	no	no	no
1001.50d	0.9992	drmcscs	B-V.0	1977	293.6	3175	263	20.0	yes	no	no	no	no
1001.53c	0.9992	endf5mt[1]	B-V.0	1977	587.2	4001	394	20.0	yes	no	no	no	no
1001.60c	0.9992	endf60	B-VI.1	1989	293.6	3484	357	100.0	yes	no	no	no	no
** H-2 **													
1002.35c	1.9968	endl85	LLNL	<1985	0.0	2507	135	20.0	yes	no	no	no	no
1002.50c	1.9968	endl5p	B-V.0	1967	293.6	3987	214	20.0	yes	no	no	no	no
1002.50d	1.9968	dre5	B-V.0	1967	293.6	4686	263	20.0	yes	no	no	no	no
1002.55c	1.9968	rmccs	T-2	1982	293.6	5981	285	20.0	yes	no	no	no	no
1002.55d	1.9968	drmcscs	T-2	1982	293.6	5343	263	20.0	yes	no	no	no	no
1002.60c	1.9968	endf60	B-VI.0	1967[2]	293.6	2704	178	20.0	yes	no	no	no	no
** H-3 **													
1003.35c	2.9901	endl85	LLNL	<1985	0.0	1269	76	20.0	no	no	no	no	no
1003.42c	2.9901	endl92	LLNL	<1992	300.0	2308	52	30.0	no	no	no	no	no
1003.50c	2.9901	rmccs	B-V.0	1965	293.6	2428	184	20.0	no	no	no	no	no
1003.50d	2.9901	drmcscs	B-V.0	1965	293.6	2807	263	20.0	no	no	no	no	no
1003.60c	2.9901	endf60	B-VI.0	1965	293.6	3338	180	20.0	no	no	no	no	no
<b>Z = 2 ***** Helium *****</b>													
** He-3 **													
2003.35c	2.9901	endl85	LLNL	<1985	0.0	2481	182	20.0	yes	no	no	no	no
2003.42c	2.9901	endl92	LLNL	<1992	300.0	1477	151	30.0	yes	no	no	no	no
2003.50c	2.9901	rmccs	B-V.0	1971	293.6	2320	229	20.0	no	no	no	no	no
2003.50d	2.9901	drmcscs	B-V.0	1971	293.6	2612	263	20.0	no	no	no	no	no
2003.60c	2.9890	endf60	B-VI.1	1990	293.6	2834	342	20.0	no	no	no	no	no
** He-4 **													
2004.35c	3.9682	endl85	LLNL	<1985	0.0	1442	78	20.0	no	no	no	no	no
2004.42c	3.9682	endl92	LLNL	<1992	300.0	1332	49	30.0	no	no	no	no	no
2004.50c	4.0015	rmccs	B-V.0	1973	293.6	3061	345	20.0	no	no	no	no	no
2004.50d	4.0015	drmcscs	B-V.0	1973	293.6	2651	263	20.0	no	no	no	no	no
2004.60c	4.0015	endf60	B-VI.0	1973	293.6	2971	327	20.0	no	no	no	no	no
<b>Z = 3 ***** Lithium *****</b>													
** Li-6 **													
3006.42c	5.9635	endl92	LLNL	<1992	300.0	7805	294	30.0	yes	no	no	no	no
3006.50c	5.9634	rmccs	B-V.0	1977	293.6	9932	373	20.0	yes	no	no	no	no
3006.50d	5.9634	drmcscs	B-V.0	1977	293.6	8716	263	20.0	yes	no	no	no	no
3006.60c	5.9634	endf60	B-VI.1	1989	293.6	12385	498	20.0	yes	no	no	no	no
** Li-7 **													
3007.42c	6.9557	endl92	LLNL	<1992	300.0	5834	141	30.0	yes	no	no	no	no
3007.50c	6.9557	endl5p	B-V.0	1972	293.6	4864	343	20.0	yes	no	no	no	no
3007.50d	6.9557	dre5	B-V.0	1972	293.6	4935	263	20.0	yes	no	no	no	no
3007.55c	6.9557	rmccs	B-V.2	1979	293.6	13171	328	20.0	yes	no	no	no	no
3007.55d	6.9557	drmcscs	B-V.2	1979	293.6	12647	263	20.0	yes	no	no	no	no
3007.60c	6.9557	endf60	B-VI.0	1988	293.6	14567	387	20.0	yes	no	no	no	no
<b>Z = 4 ***** Beryllium *****</b>													
** Be-7 **													
4007.35c	6.9567	endl85	LLNL	<1985	0.0	1834	180	20.0	no	no	no	no	no
4007.42c	6.9567	endl92	LLNL	<1992	300.0	1544	127	30.0	yes	no	no	no	no
** Be-9 **													
4009.21c	8.9348	100xs[3]	T-2:X-5	1989	300.0	28964	316	100.0	yes	no	no	no	no
4009.50c	8.9348	rmccs	B-V.0	1976	293.6	8886	329	20.0	yes	no	no	no	no
4009.50d	8.9348	drmcscs	B-V.0	1976	293.6	8756	263	20.0	yes	no	no	no	no
4009.60c	8.9348	endf60	B-VI.0	1986	293.6	64410	276	20.0	yes	no	no	no	no
<b>Z = 5 ***** Boron *****</b>													

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**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
<b>** B-10 **</b>													
5010.42c	9.9269	endl92	LLNL	<1992	300.0	4733	175	30.0	yes	no	no	no	no
5010.50c	9.9269	rmccs	B-V.0	1977	293.6	20200	514	20.0	yes	no	no	no	no
5010.50d	9.9269	drmccs	B-V.0	1977	293.6	12322	263	20.0	yes	no	no	no	no
5010.53c	9.9269	endf5mt[1]	B-V.0	1977	587.2	23676	700	20.0	yes	no	no	no	no
5010.60c	9.9269	endf60	B-VI.1	1989	293.6	27957	673	20.0	yes	no	no	no	no
<b>** B-11 **</b>													
5011.35c	10.9147	endl85	LLNL	<1985	0.0	4289	247	20.0	yes	no	no	no	no
5011.42c	10.9147	endl92	LLNL	<1992	300.0	4285	244	30.0	yes	no	no	no	no
5011.50c	10.9150	endf5p	B-V.0	1974	293.6	4344	487	20.0	no	no	no	no	no
5011.50d	10.9150	dre5	B-V.0	1974	293.6	2812	263	20.0	no	no	no	no	no
5011.55c	10.9150	rmccsa	B-V.0:T-2	1971[4]	293.6	12254	860	20.0	yes	no	no	no	no
5011.55d	10.9150	drmccs	B-V.0:T-2	1971[4]	293.6	7106	263	20.0	yes	no	no	no	no
5011.56c	10.9147	newxs	T-2	1986	293.6	56929	1762	20.0	yes	no	no	no	no
5011.56d	10.9147	newxsd	T-2	1986	293.6	17348	263	20.0	yes	no	no	no	no
5011.60c	10.9147	endf60	B-VI.0	1989	293.6	108351	2969	20.0	yes	no	no	no	no
Z = 6 ***** Carbon *****													
<b>** C-nat **</b>													
6000.50c	11.8969	rmccs	B-V.0	1977	293.6	23326	875	20.0	yes	no	no	no	no
6000.50d	11.8969	drmccs	B-V.0	1977	293.6	16844	263	20.0	yes	no	no	no	no
6000.60c	11.8980	endf60	B-VI.1	1989	293.6	22422	978	32.0	yes	no	no	no	no
<b>** C-12 **</b>													
6012.21c	11.8969	100xs[3]	T-2:X-5	1989	300.0	28809	919	100.0	yes	no	no	no	no
6012.35c	11.8969	endl85	LLNL	<1985	0.0	5154	225	20.0	yes	no	no	no	no
6012.42c	11.8969	endl92	LLNL	<1992	300.0	6229	191	30.0	yes	no	no	no	no
6012.50c	11.8969	rmccs[5]	B-V.0	1977	293.6	23326	875	20.0	yes	no	no	no	no
6012.50d	11.8969	drmccs[5]	B-V.0	1977	293.6	16844	263	20.0	yes	no	no	no	no
<b>** C-13 **</b>													
6013.35c	12.8916	endl85	LLNL	<1985	0.0	4886	395	20.0	yes	no	no	no	no
6013.42c	12.8916	endl92	LLNL	<1992	300.0	5993	429	30.0	yes	no	no	no	no
Z = 7 ***** Nitrogen *****													
<b>** N-14 **</b>													
7014.42c	13.8828	endl92	LLNL	<1992	300.0	20528	770	30.0	yes	no	no	no	no
7014.50c	13.8830	rmccs	B-V.0	1973	293.6	45457	1196	20.0	yes	no	no	no	no
7014.50d	13.8830	drmccs	B-V.0	1973	293.6	26793	263	20.0	yes	no	no	no	no
7014.60c	13.8828	endf60	T-2	1992	293.6	60397	1379	20.0	yes	no	no	no	no
<b>** N-15 **</b>													
7015.42c	14.8713	endl92	LLNL	<1992	300.0	22590	352	30.0	yes	no	no	no	no
7015.55c	14.8710	rmccsa	T-2	1983	293.6	20920	744	20.0	yes	no	no	no	no
7015.55d	14.8710	drmccs	T-2	1983	293.6	15273	263	20.0	yes	no	no	no	no
7015.60c	14.8710	endf60	B-VI.0	1993	293.6	24410	653	20.0	yes	no	no	no	no
Z = 8 ***** Oxygen *****													
<b>** O-16 **</b>													
8016.21c	15.8575	100xs[3]	T-2:X-5	1989	300.0	45016	1427	100.0	yes	no	no	no	no
8016.35c	15.8575	endl85	LLNL	<1985	0.0	10357	465	20.0	yes	no	no	no	no
8016.42c	15.8575	endl92	LLNL	<1992	300.0	9551	337	30.0	yes	no	no	no	no
8016.50c	15.8580	rmccs	B-V.0	1972	293.6	37942	1391	20.0	yes	no	no	no	no
8016.50d	15.8580	drmccs	B-V.0	1972	293.6	20455	263	20.0	yes	no	no	no	no
8016.53c	15.8580	endf5mt[1]	B-V.0	1972	587.2	37989	1398	20.0	yes	no	no	no	no
8016.54c	15.8580	endf5mt[1]	B-V.0	1972	880.8	38017	1402	20.0	yes	no	no	no	no
8016.60c	15.8532	endf60	B-VI.0	1990	293.6	58253	1609	20.0	yes	no	no	no	no
<b>** O-17 **</b>													
8017.60c	16.8531	endf60	B-VI.0	1978	293.6	4200	335	20.0	no	no	no	no	no
Z = 9 ***** Fluorine *****													
<b>** F-19 **</b>													
9019.35c	18.8352	endl85	LLNL	<1985	0.0	31547	1452	20.0	yes	no	no	no	no
9019.42c	18.8352	endl92	LLNL	<1992	300.0	37814	1118	30.0	yes	no	no	no	no
9019.50c	18.8350	endl5p	B-V.0	1976	293.6	44130	1569	20.0	yes	no	no	no	no

**APPENDIX G**  
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**TABLE G-2 (Cont.)**  
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ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
9019.50d	18.8350	dre5	B-V.0	1976	293.6	23156	263	20.0	yes	no	no	no	no
9019.51c	18.8350	rmccs	B-V.0	1976	293.6	41442	1541	20.0	yes	no	no	no	no
9019.51d	18.8350	drmccs	B-V.0	1976	293.6	23156	263	20.0	yes	no	no	no	no
9019.60c	18.8350	endf60	B-VI.0	1990	300.0	93826	1433	20.0	yes	no	no	no	no
Z = 10 ***** Neon *****													
** Ne-20 **													
10020.42c	19.8207	endl92	LLNL	<1992	300.0	14286	1011	30.0	yes	no	no	no	no
Z = 11 ***** Sodium *****													
** Na-23 **													
11023.35c	22.7923	endl85	LLNL	<1985	0.0	22777	1559	20.0	yes	no	no	no	no
11023.42c	22.7923	endl92	LLNL	<1992	300.0	19309	1163	30.0	yes	no	no	no	no
11023.50c	22.7920	endf5p	B-V.0	1977	293.6	52252	2703	20.0	yes	no	no	no	no
11023.50d	22.7920	dre5	B-V.0	1977	293.6	41665	263	20.0	yes	no	no	no	no
11023.51c	22.7920	rmccs	B-V.0	1977	293.6	48863	2228	20.0	yes	no	no	no	no
11023.51d	22.7920	drmccs	B-V.0	1977	293.6	41665	263	20.0	yes	no	no	no	no
11023.60c	22.7920	endf60	B-VI.1	1977	293.6	50294	2543	20.0	yes	no	no	no	no
Z = 12 ***** Magnesium *****													
** Mg-nat **													
12000.35c	24.0962	endl85	LLNL	<1985	0.0	9686	675	20.0	yes	no	no	no	no
12000.42c	24.0962	endl92	LLNL	<1992	300.0	9288	468	30.0	yes	no	no	no	no
12000.50c	24.0963	endf5u	B-V.0	1978	293.6	56334	2430	20.0	yes	no	no	no	no
12000.50d	24.0963	dre5	B-V.0	1978	293.6	14070	263	20.0	yes	no	no	no	no
12000.51c	24.0963	rmccs	B-V.0	1978	293.6	48917	1928	20.0	yes	no	no	no	no
12000.51d	24.0963	drmccs	B-V.0	1978	293.6	14070	263	20.0	yes	no	no	no	no
12000.60c	24.0963	endf60	B-VI.0	1978	293.6	55776	2525	20.0	yes	no	no	no	no
Z = 13 ***** Aluminum *****													
** Al-27 **													
13027.21c	26.7498	100xs[3]	T-2:X-5	1989	300.0	35022	1473	100.0	yes	no	no	no	no
13027.35c	26.7498	endl85	LLNL	<1985	0.0	36895	2038	20.0	yes	no	no	no	no
13027.42c	26.7498	endl92	LLNL	<1992	300.0	32388	1645	30.0	yes	no	no	no	no
13027.50c	26.7500	rmccs	B-V.0	1973	293.6	54162	2028	20.0	yes	no	no	no	no
13027.50d	26.7500	drmccs	B-V.0	1973	293.6	41947	263	20.0	yes	no	no	no	no
13027.60c	26.7500	endf60	B-VI.0	1973	293.6	55427	2241	20.0	yes	no	no	no	no
Z = 14 ***** Silicon *****													
** Si-nat **													
14000.21c	27.8440	100xs[3]	T-2:X-5	1989	300.0	76399	2883	100.0	yes	no	no	no	no
14000.35c	27.8442	endl85	LLNL	<1985	0.0	19016	1012	20.0	yes	no	no	no	no
14000.42c	27.8442	endl92	LLNL	<1992	300.0	16696	855	30.0	yes	no	no	no	no
14000.50c	27.8440	endf5p	B-V.0	1976	293.6	98609	2440	20.0	yes	no	no	no	no
14000.50d	27.8440	dre5	B-V.0	1976	293.6	69498	263	20.0	yes	no	no	no	no
14000.51c	27.8440	rmccs	B-V.0	1976	293.6	88129	1887	20.0	yes	no	no	no	no
14000.51d	27.8440	drmccs	B-V.0	1976	293.6	69498	263	20.0	yes	no	no	no	no
14000.60c	27.8440	endf60	B-VI.0	1976	293.6	104198	2824	20.0	yes	no	no	no	no
Z = 15 ***** Phosphorus *****													
** P-31 **													
15031.35c	30.7077	endl85	LLNL	<1985	0.0	5875	303	20.0	yes	no	no	no	no
15031.42c	30.7077	endl92	LLNL	<1992	300.0	6805	224	30.0	yes	no	no	no	no
15031.50c	30.7080	endf5u	B-V.0	1977	293.6	5733	326	20.0	yes	no	no	no	no
15031.50d	30.7080	dre5	B-V.0	1977	293.6	5761	263	20.0	yes	no	no	no	no
15031.51c	30.7080	rmccs	B-V.0	1977	293.6	5732	326	20.0	yes	no	no	no	no
15031.51d	30.7080	drmccs	B-V.0	1977	293.6	5761	263	20.0	yes	no	no	no	no
15031.60c	30.7080	endf60	B-VI.0	1977	293.6	6715	297	20.0	yes	no	no	no	no

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**TABLE G-2 (Cont.)**  
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ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
Z = 16 ***** Sulfur *****													
** S-nat **													
16000.60c	31.7882	endf60	B-VI.0	1979	293.6	108683	8382	20.0	yes	no	no	no	no
** S-32 **													
16032.35c	31.6974	endl85	LLNL	<1985	0.0	7054	357	20.0	yes	no	no	no	no
16032.42c	31.6974	endl92	LLNL	<1992	300.0	6623	307	30.0	yes	no	no	no	no
16032.50c	31.6970	endl5u	B-V.0	1977	293.6	6789	363	20.0	yes	no	no	no	no
16032.50d	31.6970	dre5	B-V.0	1977	293.6	6302	263	20.0	yes	no	no	no	no
16032.51c	31.6970	rmccs	B-V.0	1977	293.6	6780	362	20.0	yes	no	no	no	no
16032.51d	31.6970	drmccs	B-V.0	1977	293.6	6302	263	20.0	yes	no	no	no	no
16032.60c	31.6970	endf60	B-VI.0	1977	293.6	7025	377	20.0	yes	no	no	no	no
Z = 17 ***** Chlorine *****													
** Cl-nat **													
17000.35c	35.1484	endl85	LLNL	<1985	0.0	12903	1014	20.0	yes	no	no	no	no
17000.42c	35.1484	endl92	LLNL	<1992	300.0	12012	807	30.0	yes	no	no	no	no
17000.50c	35.1480	endl5p	B-V.0	1967	293.6	23313	1499	20.0	yes	no	no	no	no
17000.50d	35.1480	dre5	B-V.0	1967	293.6	18209	263	20.0	yes	no	no	no	no
17000.51c	35.1480	rmccs	B-V.0	1967	293.6	21084	1375	20.0	yes	no	no	no	no
17000.51d	35.1480	drmccs	B-V.0	1967	293.6	18209	263	20.0	yes	no	no	no	no
17000.60c	35.1480	endf60	B-VI.0	1967	293.6	24090	1816	20.0	yes	no	no	no	no
Z = 18 ***** Argon *****													
** Ar-nat **													
18000.35c	39.6048	rmccsa	LLNL	<1985	0.0	5585	259	20.0	yes	no	no	no	no
18000.35d	39.6048	drmccs	LLNL	<1985	0.0	14703	263	20.0	yes	no	no	no	no
18000.42c	39.6048	endl92	LLNL	<1992	300.0	5580	152	30.0	yes	no	no	no	no
18000.59c	39.6048	misc5xs[6,7]	T-2	1982	293.6	3473	252	20.0	yes	no	no	no	no
Z = 19 ***** Potassium *****													
** K-nat **													
19000.35c	38.7624	endl85	LLNL	<1985	0.0	11130	714	20.0	yes	no	no	no	no
19000.42c	38.7624	endl92	LLNL	<1992	300.0	11060	544	30.0	yes	no	no	no	no
19000.50c	38.7660	endl5u	B-V.0	1974	293.6	22051	1243	20.0	yes	no	no	no	no
19000.50d	38.7660	dre5	B-V.0	1974	293.6	23137	263	20.0	yes	no	no	no	no
19000.51c	38.7660	rmccs	B-V.0	1974	293.6	18798	1046	20.0	yes	no	no	no	no
19000.51d	38.7660	drmccs	B-V.0	1974	293.6	23137	263	20.0	yes	no	no	no	no
19000.60c	38.7660	endf60	B-VI.0	1974	293.6	24482	1767	20.0	yes	no	no	no	no
Z = 20 ***** Calcium *****													
** Ca-nat **													
20000.35c	39.7357	endl85	LLNL	<1985	0.0	12933	974	20.0	yes	no	no	no	no
20000.42c	39.7357	endl92	LLNL	<1992	300.0	13946	1002	30.0	yes	no	no	no	no
20000.50c	39.7360	endl5u	B-V.0	1976	293.6	62624	2394	20.0	yes	no	no	no	no
20000.50d	39.7360	dre5	B-V.0	1976	293.6	29033	263	20.0	yes	no	no	no	no
20000.51c	39.7360	rmccs	B-V.0	1976	293.6	53372	1796	20.0	yes	no	no	no	no
20000.51d	39.7360	drmccs	B-V.0	1976	293.6	29033	263	20.0	yes	no	no	no	no
20000.60c	39.7360	endf60	B-VI.0	1980	293.6	76468	2704	20.0	yes	no	no	no	no
** Ca-40 **													
20040.21c	39.6193	100xs[3]	T-2:X-5	1989	300.0	53013	2718	100.0	yes	no	no	no	no
Z = 21 ***** Scandium *****													
** Sc-45 **													
21045.60c	44.5679	endf60	B-VI.2	1992	293.6	105627	10639	20.0	yes	no	no	no	no
Z = 22 ***** Titanium *****													
** Ti-nat **													
22000.35c	47.4885	endl85	LLNL	<1985	0.0	13421	1337	20.0	yes	no	no	no	no
22000.42c	47.4885	endl92	LLNL	<1992	300.0	8979	608	30.0	yes	no	no	no	no

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**TABLE G-2 (Cont.)**  
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ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
22000.50c	47.4676	endf5u	B-V.0	1977	293.6	54801	4434	20.0	yes	no	no	no	no
22000.50d	47.4676	dre5	B-V.0	1977	293.6	10453	263	20.0	yes	no	no	no	no
22000.51c	47.4676	rmccs	B-V.0	1977	293.6	31832	1934	20.0	yes	no	no	no	no
22000.51d	47.4676	drmccs	B-V.0	1977	293.6	10453	263	20.0	yes	no	no	no	no
22000.60c	47.4676	endf60	B-VI.0	1977	293.6	76454	7761	20.0	yes	no	no	no	no
Z = 23 ***** Vanadium *****													
** V-nat **													
23000.50c	50.5040	endf5u	B-V.0	1977	293.6	38312	2265	20.0	yes	no	no	no	no
23000.50d	50.5040	dre5	B-V.0	1977	293.6	8868	263	20.0	yes	no	no	no	no
23000.51c	50.5040	rmccs	B-V.0	1977	293.6	34110	1899	20.0	yes	no	no	no	no
23000.51d	50.5040	drmccs	B-V.0	1977	293.6	8868	263	20.0	yes	no	no	no	no
23000.60c	50.5040	endf60	B-VI.0	1988	293.6	167334	8957	20.0	yes	no	no	no	no
** V-51 **													
23051.42c	50.5063	endl92	LLNL	<1992	300.0	94082	5988	30.0	yes	no	no	no	no
Z = 24 ***** Chromium *****													
** Cr-nat **													
24000.35c	51.5493	endl85	LLNL	<1985	0.0	9218	358	20.0	yes	no	no	no	no
24000.42c	51.5493	endl92	LLNL	<1992	300.0	12573	377	30.0	yes	no	no	no	no
24000.50c	51.5490	rmccs	B-V.0	1977	293.6	134454	11050	20.0	yes	no	no	no	no
24000.50d	51.5490	drmccs	B-V.0	1977	293.6	30714	263	20.0	yes	no	no	no	no
** Cr-50 **													
24050.60c	49.5170	endf60	B-VI.1	1989	293.6	119178	11918	20.0	yes	no	no	no	no
** Cr-52 **													
24052.60c	51.4940	endf60	B-VI.1	1989	293.6	117680	10679	20.0	yes	no	no	no	no
** Cr-53 **													
24053.60c	52.4860	endf60	B-VI.1	1989	293.6	114982	10073	20.0	yes	no	no	no	no
** Cr-54 **													
24054.60c	53.4760	endf60	B-VI.1	1989	293.6	98510	9699	20.0	yes	no	no	no	no
Z = 25 ***** Manganese *****													
** Mn-55 **													
25055.35c	54.4661	endl85	LLNL	<1985	0.0	7493	446	20.0	yes	no	no	no	no
25055.42c	54.4661	endl92	LLNL	<1992	300.0	10262	460	30.0	yes	no	no	no	no
25055.50c	54.4661	endf5u	B-V.0	1977	293.6	105093	12525	20.0	yes	no	no	no	no
25055.50d	54.4661	dre5	B-V.0	1977	293.6	9681	263	20.0	yes	no	no	no	no
25055.51c	54.4661	rmccs	B-V.0	1977	293.6	25727	1578	20.0	yes	no	no	no	no
25055.51d	54.4661	drmccs	B-V.0	1977	293.6	9681	263	20.0	yes	no	no	no	no
25055.60c	54.4661	endf60	B-VI.0	1988	293.6	184269	8207	20.0	yes	no	no	no	no
Z = 26 ***** Iron *****													
** Fe-nat **													
26000.21c	55.3650	100xs[3]	T-2:X-5	1989	300.0	149855	15598	100.0	yes	no	no	no	no
26000.35c	55.3672	endl85	LLNL	<1985	0.0	30983	2772	20.0	yes	no	no	no	no
26000.42c	55.3672	endl92	LLNL	<1992	300.0	38653	3385	30.0	yes	no	no	no	no
26000.50c	55.3650	endl5p	B-V.0	1978	293.6	115447	10957	20.0	yes	no	no	no	no
26000.50d	55.3650	dre5	B-V.0	1978	293.6	33896	263	20.0	yes	no	no	no	no
26000.55c	55.3650	rmccs	T-2	1986	293.6	178392	6899	20.0	yes	no	no	no	no
26000.55d	55.3650	drmccs	T-2	1986	293.6	72632	263	20.0	yes	no	no	no	no
** Fe-54 **													
26054.60c	53.4760	endf60	B-VI.1	1989	293.6	121631	10701	20.0	yes	no	no	no	no
** Fe-56 **													
26056.60c	55.4540	endf60	B-VI.1	1989	293.6	174517	11618	20.0	yes	no	no	no	no
** Fe-57 **													
26057.60c	56.4460	endf60	B-VI.1	1989	293.6	133995	7606	20.0	yes	no	no	no	no
** Fe-58 **													
26058.60c	57.4360	endf60	B-VI.1	1989	293.6	93450	6788	20.0	yes	no	no	no	no
Z = 27 ***** Cobalt *****													
** Co-59 **													

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**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
27059.35c	58.4269	endl85	LLNL	<1985	0.0	38958	4177	20.0	yes	no	no	no	no
27059.42c	58.4269	endl92	LLNL	<1992	300.0	119231	13098	30.0	yes	no	no	no	no
27059.50c	58.4269	endf5u	B-V.0	1977	293.6	117075	14502	20.0	yes	no	no	no	no
27059.50d	58.4269	dre5	B-V.0	1977	293.6	11769	263	20.0	yes	no	no	no	no
27059.51c	58.4269	rmccs	B-V.0	1977	293.6	28355	1928	20.0	yes	no	no	no	no
27059.51d	58.4269	drmccs	B-V.0	1977	293.6	11769	263	20.0	yes	no	no	no	no
27059.60c	58.4269	endl60	B-VI.2	1992	293.6	186618	11838	20.0	yes	no	no	no	no
Z = 28 ***** Nickel *****													
** Ni-nat **													
28000.42c	58.1957	endl92	LLNL	<1992	300.0	44833	3116	30.0	yes	no	no	no	no
28000.50c	58.1826	rmccs	B-V.0	1977	293.6	139913	8927	20.0	yes	no	no	no	no
28000.50d	58.1826	drmccs	B-V.0	1977	293.6	21998	263	20.0	yes	no	no	no	no
** Ni-58 **													
28058.35c	57.4376	endl85	LLNL	<1985	0.0	42744	4806	20.0	yes	no	no	no	no
28058.42c	57.4376	endl92	LLNL	<1992	300.0	38930	4914	30.0	yes	no	no	no	no
28058.60c	57.4380	endlf60	B-VI.1	1989	293.6	172069	16445	20.0	yes	no	no	no	no
** Ni-60 **													
28060.60c	59.4160	endlf60	B-VI.1	1991	293.6	110885	10055	20.0	yes	no	no	no	no
** Ni-61 **													
28061.60c	60.4080	endlf60	B-VI.1	1989	293.6	93801	5882	20.0	yes	no	no	no	no
** Ni-62 **													
28062.60c	61.3960	endlf60	B-VI.1	1989	293.6	82085	7230	20.0	yes	no	no	no	no
** Ni-64 **													
28064.60c	63.3790	endlf60	B-VI.1	1989	293.6	66656	6144	20.0	yes	no	no	no	no
Z = 29 ***** Copper *****													
** Cu-nat **													
29000.35c	63.0001	endl85	LLNL	<1985	0.0	7039	293	20.0	yes	no	no	no	no
29000.50c	63.5460	rmccs	B-V.0	1978	293.6	51850	3435	20.0	yes	no	no	no	no
29000.50d	63.5460	drmccs	B-V.0	1978	293.6	12777	263	20.0	yes	no	no	no	no
** Cu-63 **													
29063.60c	62.3890	endlf60	B-VI.2	1989	293.6	119097	11309	20.0	yes	no	no	no	no
** Cu-65 **													
29065.60c	64.3700	endlf60	B-VI.2	1989	293.6	118385	11801	20.0	yes	no	no	no	no
Z = 30 ***** Zinc *****													
** Zn-nat **													
30000.40c	64.8183	endl92	LLNL	<1992	300.0	271897	33027	30.0	yes	no	no	no	no
30000.42c	64.8183	endl92	LLNL:X-5	<1992	300.0	271897	33027	30.0	yes	no	no	no	no
Z = 31 ***** Gallium *****													
** Ga-nat **													
31000.35c	69.1211	endl85	LLNL	<1985	0.0	7509	469	20.0	yes	no	no	no	no
31000.42c	69.1211	endl92	LLNL	<1992	300.0	6311	219	30.0	yes	no	no	no	no
31000.50c	69.1211	rmccs	B-V.0	1980	293.6	7928	511	20.0	yes	no	no	no	no
31000.50d	69.1211	drmccs	B-V.0	1980	293.6	6211	263	20.0	yes	no	no	no	no
31000.60c	69.1211	endlf60	B-VI.0	1980	293.6	9228	566	20.0	yes	no	no	no	no
Z = 33 ***** Arsenic *****													
** As-74 **													
33074.35c	73.2889	endl85	LLNL	<1985	0.0	50881	6424	20.0	yes	no	no	no	no
33074.42c	73.2889	endl92	LLNL	<1992	300.0	55752	6851	30.0	yes	no	no	no	no
** As-75 **													
33075.35c	74.2780	rmccsa	B-V.0	1974	0.0	50931	6421	20.0	yes	no	no	no	no
33075.35d	74.2780	drmccs	B-V.0	1974	0.0	8480	263	20.0	yes	no	no	no	no
33075.42c	74.2780	endl92	LLNL	<1992	300.0	56915	6840	30.0	yes	no	no	no	no
Z = 35 ***** Bromine *****													
** Br-79 **													

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**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
35079.55c	78.2404	misc5xs[6,8]		T-2	1982	293.6	10431	1589	20.0	no	no	no	no
** Br-81 **													
35081.55c	80.2212	misc5xs[6,8]		T-2	1982	293.6	5342	831	20.0	no	no	no	no
Z = 36 ***** Krypton *****													
** Kr-78 **													
36078.50c	77.2510	rmccsa	B-V.0	1978	293.6	9057	939	20.0	no	no	no	no	no
36078.50d	77.2510	drmcgs	B-V.0	1978	293.6	4358	263	20.0	no	no	no	no	no
** Kr-80 **													
36080.50c	79.2298	rmccsa	B-V.0	1978	293.6	10165	1108	20.0	no	no	no	no	no
36080.50d	79.2298	drmcgs	B-V.0	1978	293.6	4276	263	20.0	no	no	no	no	no
** Kr-82 **													
36082.50c	81.2098	rmccsa	B-V.0	1978	293.6	7220	586	20.0	no	no	no	no	no
36082.50d	81.2098	drmcgs	B-V.0	1978	293.6	4266	263	20.0	no	no	no	no	no
36082.59c	81.2098	misc5xs[6,7]	T-2	1982	293.6	7010	499	20.0	yes	no	no	no	no
** Kr-83 **													
36083.50c	82.2018	rmccsa	B-V.0	1978	293.6	8078	811	20.0	no	no	no	no	no
36083.50d	82.2018	drmcgs	B-V.0	1978	293.6	4359	263	20.0	no	no	no	no	no
36083.59c	82.2018	misc5xs[6,7]	T-2	1982	293.6	8069	704	20.0	yes	no	no	no	no
** Kr-84 **													
36084.50c	83.1906	rmccsa	B-V.0	1978	293.6	9364	944	20.0	no	no	no	no	no
36084.50d	83.1906	drmcgs	B-V.0	1978	293.6	4463	263	20.0	no	no	no	no	no
36084.59c	83.1906	misc5xs[6,7]	T-2	1982	293.6	10370	954	20.0	yes	no	no	no	no
** Kr-86 **													
36086.50c	85.1726	rmccsa	B-V.0	1975	293.6	10416	741	20.0	no	no	no	no	no
36086.50d	85.1726	drmcgs	B-V.0	1975	293.6	4301	263	20.0	no	no	no	no	no
36086.59c	85.1726	misc5xs[6,7]	T-2	1982	293.6	8740	551	20.0	yes	no	no	no	no
Z = 37 ***** Rubidium *****													
** Rb-85 **													
37085.55c	84.1824	misc5xs[6,8]		T-2	1982	293.6	27304	4507	20.0	no	no	no	no
** Rb-87 **													
37087.55c	86.1626	misc5xs[6,8]		T-2	1982	293.6	8409	1373	20.0	no	no	no	no
Z = 39 ***** Yttrium *****													
** Y-88 **													
39088.35c	87.1543	endl85	LLNL	<1985	0.0	11299	272	20.0	yes	no	no	no	no
39088.42c	87.1543	endl92	LLNL	<1992	300.0	11682	181	30.0	yes	no	no	no	no
** Y-89 **													
39089.35c	88.1421	misc5xs[6]	LLNL	<1985	0.0	49885	6154	20.0	yes	no	no	no	no
39089.42c	88.1421	endl92	LLNL	<1992	300.0	69315	8771	30.0	yes	no	no	no	no
39089.50c	88.1421	endl5u	B-V.0[9]	1985	293.6	18631	3029	20.0	no	no	no	no	no
39089.50d	88.1421	dre5	B-V.0[9]	1985	293.6	2311	263	20.0	no	no	no	no	no
39089.60c	88.1420	endl60	B-V.I.0	1986	293.6	86556	9567	20.0	yes	no	no	no	no
Z = 40 ***** Zirconium *****													
** Zr-nat **													
40000.35c	90.4364	endl85	LLNL	<1985	0.0	14738	1292	20.0	yes	no	no	no	no
40000.42c	90.4364	endl92	LLNL	<1992	300.0	131855	17909	30.0	yes	no	no	no	no
40000.56c	90.4360	misc5xs[6,10]	B-V:X-5	1976	300.0	52064	7944	20.0	no	no	no	no	no
40000.56d	90.4360	misc5xs[6,10]	B-V:X-5	1976	300.0	5400	263	20.0	no	no	no	no	no
40000.57c	90.4360	misc5xs[6,10]	B-V:X-5	1976	300.0	16816	2116	20.0	no	no	no	no	no
40000.57d	90.4360	misc5xs[6,10]	B-V:X-5	1976	300.0	5400	263	20.0	no	no	no	no	no
40000.58c	90.4360	misc5xs[6,10]	B-V:X-5	1976	587.2	57528	8777	20.0	no	no	no	no	no
40000.60c	90.4360	endl60	B-V.I.0	1976[10]	293.6	66035	10298	20.0	no	no	no	no	no
** Zr-93 **													
40093.50c	92.1083	kidman	B-V.0	1974	293.6	2579	236	20.0	no	no	no	no	no
Z = 41 ***** Niobium *****													
** Nb-93 **													
41093.35c	92.1083	endl85	LLNL	<1985	0.0	50441	6095	20.0	yes	no	no	no	no

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**TABLE G-2 (Cont.)**  
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ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
41093.42c	92.1083	endl92	LLNL	<1992	300.0	73324	9277	30.0	yes	no	no	no	no
41093.50c	92.1051	endf5p	B-V.0	1974	293.6	128960	17279	20.0	yes	no	no	no	no
41093.50d	92.1051	dre5	B-V.0	1974	293.6	10332	263	20.0	yes	no	no	no	no
41093.51c	92.1051	rmccs	B-V.0	1974	293.6	14675	963	20.0	yes	no	no	no	no
41093.51d	92.1051	drmccs	B-V.0	1974	293.6	10332	263	20.0	yes	no	no	no	no
41093.60c	92.1051	endf60	B-VI.1	1990	293.6	110269	10678	20.0	yes	no	no	no	no
Z = 42 ***** Molybdenum *****													
** Mo-nat **													
42000.35c	95.1158	endl85	LLNL	<1985	0.0	8628	573	20.0	yes	no	no	no	no
42000.42c	95.1158	endl92	LLNL	<1992	300.0	9293	442	30.0	yes	no	no	no	no
42000.50c	95.1160	endf5u	B-V.0	1979	293.6	35634	4260	20.0	yes	no	no	no	no
42000.50d	95.1160	dre5	B-V.0	1979	293.6	7754	263	20.0	yes	no	no	no	no
42000.51c	95.1160	rmccs	B-V.0	1979	293.6	10139	618	20.0	yes	no	no	no	no
42000.51d	95.1160	drmccs	B-V.0	1979	293.6	7754	263	20.0	yes	no	no	no	no
42000.60c	95.1160	endf60	B-VI.0	1979	293.6	45573	5466	20.0	yes	no	no	no	no
** Mo-95 **													
42095.50c	94.0906	kidman	B-V.0	1980	293.6	15411	2256	20.0	no	no	no	no	no
Z = 43 ***** Technetium *****													
** Tc-99 **													
43099.50c	98.1500	kidman	B-V.0	1978	293.6	12152	1640	20.0	no	no	no	no	no
43099.60c	98.1500	endf60	B-VI.0	1978	293.6	54262	8565	20.0	no	no	no	no	no
Z = 44 ***** Ruthenium *****													
** Ru-101 **													
44101.50c	100.0390	kidman	B-V.0	1980	293.6	5299	543	20.0	no	no	no	no	no
** Ru-103 **													
44103.50c	102.0220	kidman	B-V.0	1974	293.6	3052	235	20.0	no	no	no	no	no
Z = 45 ***** Rhodium *****													
** Rh-103 **													
45103.50c	102.0210	rmccsa	B-V.0	1978	293.6	18870	2608	20.0	no	no	no	no	no
45103.50d	102.0210	drmccs	B-V.0	1974	293.6	4663	263	20.0	no	no	no	no	no
** Rh-105 **													
45105.50c	104.0050	kidman	B-V.0	1974	293.6	1591	213	20.0	no	no	no	no	no
Z = 45 ***** Average fission product from Uranium-235 *****													
** U-235 fp **													
45117.90c	115.5446	rmccs	T-2	1982	293.6	10314	399	20.0	yes	no	no	no	no
45117.90d	115.5446	drmccs	T-2	1982	293.6	9507	263	20.0	yes	no	no	no	no
Z = 46 ***** Palladium *****													
** Pd-105 **													
46105.50c	104.0040	kidman	B-V.0	1980	293.6	4647	505	20.0	no	no	no	no	no
** Pd-108 **													
46108.50c	106.9770	kidman	B-V.0	1980	293.6	4549	555	20.0	no	no	no	no	no
Z = 46 ***** Average fission product from Plutonium-239 *****													
** Pu-239 fp **													
46119.90c	117.5255	rmccs	T-2	1982	293.6	10444	407	20.0	yes	no	no	no	no
46119.90d	117.5255	drmccs	T-2	1982	293.6	9542	263	20.0	yes	no	no	no	no
Z = 47 ***** Silver *****													
** Ag-nat **													
47000.55c	106.9420	rmccsa	T-2	1984	293.6	29092	2350	20.0	yes	no	no	no	no
47000.55d	106.9420	drmccs	T-2	1984	293.6	12409	263	20.0	yes	no	no	no	no

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**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
<b>** Ag-107 **</b>													
47107.35c	105.9867	endl85	LLNL	<1985	0.0	13134	994	20.0	yes	no	no	no	no
47107.42c	105.9867	endl92	LLNL	<1992	300.0	27108	2885	30.0	yes	no	no	no	no
47107.50c	105.9870	rmccsa	B-V.0	1978	293.6	12111	1669	20.0	no	no	no	no	no
47107.50d	105.9870	drmccs	B-V.0	1978	293.6	4083	263	20.0	no	no	no	no	no
47107.60c	105.9870	endf60	B-VI.0	1983	293.6	64008	10101	20.0	no	no	no	no	no
<b>** Ag-109 **</b>													
47109.35c	107.9692	endl85	LLNL	<1985	0.0	13452	1094	20.0	yes	no	no	no	no
47109.42c	107.9692	endl92	LLNL	<1992	300.0	33603	3796	30.0	yes	no	no	no	no
47109.50c	107.9690	rmccsa	B-V.0	1978	293.6	14585	2120	20.0	no	no	no	no	no
47109.50d	107.9690	drmccs	B-V.0	1978	293.6	3823	263	20.0	no	no	no	no	no
47109.60c	107.9690	endf60	B-VI.0	1983	293.6	76181	11903	20.0	no	no	no	no	no
Z = 48 ***** Cadmium *****													
<b>** Cd-nat **</b>													
48000.35c	111.4443	endl85	LLNL	<1985	0.0	12283	1115	20.0	yes	no	no	no	no
48000.42c	111.4443	endl92	LLNL	<1992	300.0	211537	29369	30.0	yes	no	no	no	no
48000.50c	111.4600	endf5u	B-V.0	1974	293.6	19714	2981	20.0	no	no	no	no	no
48000.50d	111.4600	dre5	B-V.0	1974	293.6	3026	263	20.0	no	no	no	no	no
48000.51c	111.4600	rmccs	B-V.0	1974	293.6	6734	818	20.0	no	no	no	no	no
48000.51d	111.4600	drmccs	B-V.0	1974	293.6	3026	263	20.0	no	no	no	no	no
Z = 49 ***** Indium *****													
<b>** In-nat **</b>													
49000.42c	113.8336	endl92	LLNL	<1992	300.0	65498	7870	30.0	yes	no	no	no	no
49000.60c	113.8340	endf60	B-VI.0	1990	293.6	93662	10116	20.0	yes	no	no	no	no
Z = 49-50 ***** Fission products *****													
<b>** Ave fp **</b>													
49120.42c	116.4906	endl92fp[11]	LLNL	<1992	300.0	12755	164	30.0	yes	no	no	no	no
49125.42c	116.4906	endl92fp[11]	LLNL	<1992	300.0	9142	119	30.0	yes	no	no	no	no
50120.35c	116.4906	rmccs	LLNL	<1985	0.0	8366	232	20.0	yes	no	no	no	no
50120.35d	116.4906	drmccs	LLNL	<1985	0.0	8963	263	20.0	yes	no	no	no	no
Z = 50 ***** Tin *****													
<b>** Sn-nat **</b>													
50000.35c	117.6704	endl85	LLNL	<1985	0.0	5970	205	20.0	yes	no	no	no	no
50000.40c	117.6704	endl92	LLNL	<1992	300.0	248212	34612	30.0	yes	no	no	no	no
50000.42c	117.6704	endl92	LLNL:X-5	<1992	300.0	248212	34612	30.0	yes	no	no	no	no
Z = 51 ***** Antimony *****													
<b>** Sb-nat **</b>													
51000.42c	120.7041	endl92	LLNL	<1992	300.0	95953	10721	30.0	yes	no	no	no	no
Z = 53 ***** Iodine *****													
<b>** I-127 **</b>													
53127.42c	125.8143	endl92	LLNL	<1992	300.0	76321	10	30.0	yes	no	no	no	no
53127.55c	125.8140	misc5xs[6,8]	T-2	1982	293.6	59725	9423	20.0	no	no	no	no	no
53127.60c	125.8143	endf60[12]	T-2	1991	293.6	399760	7888	30.0	yes	no	no	no	no
<b>** I-129 **</b>													
53129.60c	127.7980	endf60	B-VI.0	1980	293.6	8792	1237	20.0	no	no	no	no	no
<b>** I-135 **</b>													
53135.50c	133.7510	kidman	B-V.0	1974	293.6	1232	194	20.0	no	no	no	no	no
Z = 54 ***** Xenon *****													
<b>** Xe-nat **</b>													
54000.35c	130.1721	endl85	LLNL	<1985	0.0	41432	5228	20.0	yes	no	no	no	no
54000.42c	130.1721	endl92	LLNL	<1992	300.0	43411	5173	30.0	yes	no	no	no	no

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**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
** Xe-131 **													
54131.50c	129.7810	kidman	B-V.0	1978	293.6	22572	3376	20.0	no	no	no	no	no
** Xe-134 **													
54134.35c	132.7551	endl85	LLNL	<1985	0.0	7463	359	20.0	yes	no	no	no	no
54134.42c	132.7551	endl92	LLNL	<1992	300.0	8033	192	30.0	yes	no	no	no	no
** Xe-135 **													
54135.50c	133.7480	endf5mt[1]	B-V	1975	293.6	5529	704	20.0	no	no	no	no	no
54135.53c	133.7480	endf5mt[1]	B-V	1975	587.2	5541	706	20.0	no	no	no	no	no
54135.54c	133.7480	endf5mt[1]	B-V	1975	880.8	5577	712	20.0	no	no	no	no	no
Z = 55 ***** Cesium *****													
** Cs-133 **													
55133.50c	131.7640	kidman	B-V.0	1978	293.6	26713	4142	20.0	no	no	no	no	no
55133.55c	131.7640	misc5xs[6,8]	T-2	1982	293.6	67893	11025	20.0	no	no	no	no	no
55133.60c	131.7640	endlf60	B-VI.0	1978	293.6	54723	8788	20.0	no	no	no	no	no
** Cs-134 **													
55134.60c	132.7570	endlf60	B-VI.0	1988	293.6	10227	1602	20.0	no	no	no	no	no
** Cs-135 **													
55135.50c	133.7470	kidman	B-V.0	1974	293.6	1903	199	20.0	no	no	no	no	no
55135.60c	133.7470	endlf60	B-VI.0	1974	293.6	3120	388	20.0	no	no	no	no	no
** Cs-136 **													
55136.60c	134.7400	endlf60	B-VI.0	1974	293.6	10574	1748	20.0	no	no	no	no	no
** Cs-137 **													
55137.60c	135.7310	endlf60	B-VI.0	1974	293.6	2925	369	20.0	no	no	no	no	no
Z = 56 ***** Barium *****													
** Ba-138 **													
56138.35c	136.7206	endl85	LLNL	<1985	0.0	5985	262	20.0	yes	no	no	no	no
56138.50c	136.7150	rmccs	B-V.0	1978	293.6	6018	292	20.0	yes	no	no	no	no
56138.50d	136.7150	drmccs	B-V.0	1978	293.6	6320	263	20.0	yes	no	no	no	no
56138.60c	136.7150	endlf60	B-VI.0	1978	293.6	7347	267	20.0	yes	no	no	no	no
Z = 59 ***** Praseodymium *****													
** Pr-141 **													
59141.50c	139.6970	kidman	B-V.0	1980	293.6	15620	1354	20.0	no	no	no	no	no
Z = 60 ***** Neodymium *****													
** Nd-143 **													
60143.50c	141.6820	kidman	B-V.0	1980	293.6	17216	1701	20.0	no	no	no	no	no
** Nd-145 **													
60145.50c	143.6680	kidman	B-V.0	1980	293.6	38473	3985	20.0	no	no	no	no	no
** Nd-147 **													
60147.50c	145.6540	kidman	B-V.0	1979	293.6	1816	251	20.0	no	no	no	no	no
** Nd-148 **													
60148.50c	146.6460	kidman	B-V.0	1980	293.6	10867	1054	20.0	no	no	no	no	no
Z = 61 ***** Promethium *****													
** Pm-147 **													
61147.50c	145.6530	kidman	B-V.0	1980	293.6	9152	825	20.0	no	no	no	no	no
** Pm-148 **													
61148.50c	146.6470	kidman	B-V.0	1979	293.6	1643	257	20.0	no	no	no	no	no
** Pm-149 **													
61149.50c	147.6390	kidman	B-V.0	1979	293.6	2069	238	20.0	no	no	no	no	no
Z = 62 ***** Samarium *****													
** Sm-147 **													
62147.50c	145.6530	kidman	B-V.0	1980	293.6	33773	2885	20.0	no	no	no	no	no
** Sm-149 **													
62149.49c	147.6380	ures	B-VI.0	1978	300.0	57787	7392	20.0	no	no	no	no	yes
62149.50c	147.6380	endlf5u	B-V.0	1978	293.6	15662	2008	20.0	no	no	no	no	no

**APPENDIX G**  
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**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
62149.50d	147.6380	dre5	B-V.0	1978	293.6	4429	263	20.0	no	no	no	no	no
** Sm-150 **													
62150.49c	148.6290	ures	B-VI.2	1992	300.0	60992	8183	20.0	no	no	no	no	yes
62150.50c	148.6290	kidman	B-V.0	1974	293.6	9345	1329	20.0	no	no	no	no	no
** Sm-151 **													
62151.50c	149.6230	kidman	B-V.0	1980	293.6	7303	605	20.0	no	no	no	no	no
** Sm-152 **													
62152.49c	150.6150	ures	B-VI.2	1992	300.0	203407	19737	20.0	no	no	no	no	yes
62152.50c	150.6150	kidman	B-V.0	1980	293.6	41252	4298	20.0	no	no	no	no	no
Z = 63 ***** Europium *****													
** Eu-nat **													
63000.35c	150.6546	rmccsa	LLNL	<1985	0.0	6926	364	20.0	yes	no	no	no	no
63000.35d	150.6546	drmcce	LLNL	<1985	0.0	6654	263	20.0	yes	no	no	no	no
63000.42c	150.6546	endl92	LLNL	<1992	300.0	37421	4498	30.0	yes	no	no	no	no
** Eu-151 **													
63151.49c	149.6230	ures	B-VI.0	1986	300.0	147572	10471	20.0	yes	no	no	no	yes
63151.50c	149.6230	rmccs	B-V.0	1977	293.6	68057	5465	20.0	yes	no	no	no	no
63151.50d	149.6230	drmcce	B-V.0	1977	293.6	10013	263	20.0	yes	no	no	no	no
63151.55c	149.6230	newxs	T-2	1986	293.6	86575	4749	20.0	yes	no	no	no	no
63151.55d	149.6230	newxsd	T-2	1986	293.6	35199	263	20.0	yes	no	no	no	no
63151.60c	149.6230	endlf60	B-VI.0	1986	293.6	96099	7394	20.0	yes	no	no	no	no
** Eu-152 **													
63152.49c	150.6200	ures	B-VI.0	1975	300.0	81509	6540	20.0	no	no	no	no	yes
63152.50c	150.6200	endlf5u	B-V.0	1975	293.6	49313	4553	20.0	no	no	no	no	no
63152.50d	150.6200	dre5	B-V.0	1975	293.6	5655	263	20.0	no	no	no	no	no
** Eu-153 **													
63153.49c	151.6080	ures	B-VI.0	1986	300.0	129446	8784	20.0	yes	no	no	no	yes
63153.50c	151.6070	rmccs	B-V.0	1978	293.6	55231	4636	20.0	yes	no	no	no	no
63153.50d	151.6070	drmcce	B-V.0	1978	293.6	11244	263	20.0	yes	no	no	no	no
63153.55c	151.6080	newxs	T-2	1986	293.6	72971	4174	20.0	yes	no	no	no	no
63153.55d	151.6080	newxsd	T-2	1986	293.6	36372	263	20.0	yes	no	no	no	no
63153.60c	151.6080	endlf60	B-VI.0	1986	293.6	86490	6198	20.0	yes	no	no	no	no
** Eu-154 **													
63154.49c	152.6000	ures	B-VI.0	1975	300.0	72804	6627	20.0	no	no	no	no	yes
63154.50c	152.6000	endlf5u	B-V.0	1975	293.6	37008	4030	20.0	no	no	no	no	no
63154.50d	152.6000	dre5	B-V.0	1975	293.6	5458	263	20.0	no	no	no	no	no
** Eu-155 **													
63155.50c	153.5920	kidman	B-V.0	1974	293.6	4532	273	20.0	no	no	no	no	no
Z = 64 ***** Gadolinium *****													
** Gd-nat **													
64000.35c	155.8991	rmccsa	LLNL	<1985	0.0	7878	454	20.0	yes	no	no	no	no
64000.35d	155.8991	drmcce	LLNL	<1985	0.0	6833	263	20.0	yes	no	no	no	no
** Gd-152 **													
64152.50c	150.6150	endlf5u	B-V.0	1977	293.6	26251	3285	20.0	no	no	no	no	no
64152.50d	150.6150	dre5	B-V.0	1977	293.6	5899	263	20.0	no	no	no	no	no
64152.55c	150.6150	misc5xs[6,13]	B-V.0:T-2	1986	293.6	32590	3285	20.0	yes	no	no	no	no
64152.60c	150.6150	endlf60	B-VI.0	1977	293.6	32760	4391	20.0	no	no	no	no	no
** Gd-154 **													
64154.50c	152.5990	endlf5u	B-V.0	1977	293.6	49572	7167	20.0	no	no	no	no	no
64154.50d	152.5990	dre5	B-V.0	1977	293.6	5930	263	20.0	no	no	no	no	no
64154.55c	152.5990	misc5xs[6,13]	B-V.0:T-2	1986	293.6	59814	7167	20.0	yes	no	no	no	no
64154.60c	152.5990	endlf60	B-VI.0	1977	293.6	67662	10189	20.0	no	no	no	no	no
** Gd-155 **													
64155.50c	153.5920	endlf5u	B-V.0	1977	293.6	44965	6314	20.0	no	no	no	no	no
64155.50d	153.5920	dre5	B-V.0	1977	293.6	6528	263	20.0	no	no	no	no	no
64155.55c	153.5920	misc5xs[6,13]	B-V.0:T-2	1986	293.6	54346	6314	20.0	yes	no	no	no	no
64155.60c	153.5920	endlf60	B-VI.0	1977	293.6	61398	9052	20.0	no	no	no	no	no
** Gd-156 **													
64156.50c	154.5830	endlf5u	B-V.0	1977	293.6	37371	3964	20.0	no	no	no	no	no
64156.50d	154.5830	dre5	B-V.0	1977	293.6	6175	263	20.0	no	no	no	no	no
64156.55c	154.5830	misc5xs[6,13]	B-V.0:T-2	1986	293.6	44391	3964	20.0	yes	no	no	no	no
64156.60c	154.5830	endlf60	B-VI.0	1977	293.6	42885	5281	20.0	no	no	no	no	no

**APPENDIX G**  
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**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
** Gd-157 **													
64157.50c	155.5760	endf5u	B-V.0	1977	293.6	38975	5370	20.0	no	no	no	no	no
64157.50d	155.5760	dre5	B-V.0	1977	293.6	6346	263	20.0	no	no	no	no	no
64157.55c	155.5760	misc5xs[6,13]	B-V.0:T-2	1986	293.6	47271	5370	20.0	yes	no	no	no	no
64157.60c	155.5760	endf60	B-VI.0	1977	293.6	56957	8368	20.0	no	no	no	no	no
** Gd-158 **													
64158.50c	156.5670	endf5u	B-V.0	1977	293.6	95876	15000	20.0	no	no	no	no	no
64158.50d	156.5670	dre5	B-V.0	1977	293.6	5811	263	20.0	no	no	no	no	no
64158.55c	156.5670	misc5xs[6,13]	B-V.0:T-2	1986	293.6	113916	15000	20.0	yes	no	no	no	no
64158.60c	156.5670	endf60	B-VL0	1977	293.6	59210	8909	20.0	no	no	no	no	no
** Gd-160 **													
64160.50c	158.5530	endf5u	B-V.0	1977	293.6	53988	8229	20.0	no	no	no	no	no
64160.50d	158.5530	dre5	B-V.0	1977	293.6	5030	263	20.0	no	no	no	no	no
64160.55c	158.5530	misc5xs[6,13]	B-V.0:T-2	1986	293.6	65261	8229	20.0	yes	no	no	no	no
64160.60c	158.5530	endf60	B-VI.0	1977	293.6	54488	8304	20.0	no	no	no	no	no
Z = 67 ***** Holmium *****													
** Ho-165 **													
67165.35c	163.5135	rmccsa	LLNL	<1985	0.0	54279	7075	20.0	yes	no	no	no	no
67165.35d	163.5135	drmccs	LLNL	<1985	0.0	7019	263	20.0	yes	no	no	no	no
67165.42c	163.5135	endl92	LLNL	<1992	300.0	103467	13884	30.0	yes	no	no	no	no
67165.55c	163.5130	newxs	T-2	1986	293.6	56605	2426	30.0	yes	no	no	no	no
67165.55d	163.5130	newxsd	T-2	1986	293.6	42266	263	20.0	yes	no	no	no	no
67165.60c	163.5130	endf60	B-VI.0	1988	293.6	75307	4688	30.0	yes	no	no	no	no
Z = 69 ***** Thulium *****													
** Tm-169 **													
69169.55c	167.4830	misc5xs[6]	T-2	1986	300.0	47941	4738	20.0	no	no	no	no	no
Z = 72 ***** Hafnium *****													
** Hf-nat **													
72000.35c	176.9567	endl85	LLNL	<1985	0.0	75862	9636	20.0	yes	no	no	no	no
72000.42c	176.9567	endl92	LLNL	<1992	300.0	108989	14113	30.0	yes	no	no	no	no
72000.50c	176.9540	newxs	B-V.0	1976	293.6	52231	8270	20.0	no	no	no	no	no
72000.50d	176.9540	newxsd	B-V.0	1976	293.6	4751	263	20.0	no	no	no	no	no
72000.60c	176.9540	endf60	B-VI.0	1976	293.6	84369	13634	20.0	no	no	no	no	no
Z = 73 ***** Tantalum *****													
** Ta-181 **													
73181.35c	179.3936	endl85	LLNL	<1985	0.0	33547	2812	20.0	yes	no	no	no	no
73181.42c	179.3936	endl92	LLNL	<1992	300.0	47852	4927	30.0	yes	no	no	no	no
73181.50c	179.4000	endf5u	B-V.0	1972	293.6	60740	6341	20.0	yes	no	no	no	no
73181.50d	179.4000	dre5	B-V.0	1972	293.6	16361	263	20.0	yes	no	no	no	no
73181.51c	179.4000	rmccs	B-V.0	1972	293.6	21527	753	20.0	yes	no	no	no	no
73181.51d	179.4000	drmccs	B-V.0	1972	293.6	16361	263	20.0	yes	no	no	no	no
73181.60c	179.4000	endf60	B-VI.0	1972	293.6	91374	10352	20.0	yes	no	no	no	no
** Ta-182 **													
73182.49c	180.3870	ures	B-VI.0	1971	300.0	20850	2463	20.0	no	no	no	no	yes
73182.60c	180.3870	endf60	B-VI.0	1971	293.6	12085	1698	20.0	no	no	no	no	no
Z = 74 ***** Tungsten *****													
** W-nat **													
74000.21c	182.2706	100xs[3]	T-2:X-5	1989	300.0	194513	21386	100.0	yes	no	no	no	no
74000.55c	182.2770	rmccs	B-V.2	1982	293.6	50639	1816	20.0	yes	no	no	no	no
74000.55d	182.2770	drmccs	B-V.2	1982	293.6	34272	263	20.0	yes	no	no	no	no
** W-182 **													
74182.49c	180.3900	ures	B-VI.0	1980	300.0	150072	16495	20.0	yes	no	no	no	yes
74182.50c	180.3900	endf5p	B-V.0	1973	293.6	94367	11128	20.0	yes	no	no	no	no
74182.50d	180.3900	dre5	B-V.0	1973	293.6	17729	263	20.0	yes	no	no	no	no
74182.55c	180.3900	rmccsa	B-V.2	1980	293.6	122290	13865	20.0	yes	no	no	no	no
74182.55d	180.3900	drmccs	B-V.2	1980	293.6	26387	263	20.0	yes	no	no	no	no

**APPENDIX G**  
**MCNP NEUTRON CROSS-SECTION LIBRARIES**

**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library		Eval Date	Temp (°K)	Length words	E <sub>max</sub>			$\bar{V}$	CP	DN	UR
		Name	Source				MeV	GPD					
74182.60c ** W-183 **	180.3900	endf60	B-VI.0	1980	293.6	113177	12283	20.0	yes	no	no	no	no
74183.49c	181.3800	ures	B-VI.0	1980	300.0	119637	12616	20.0	yes	no	no	no	yes
74183.50c	181.3800	endf5p	B-V.0	1973	293.6	58799	5843	20.0	yes	no	no	no	no
74183.50d	181.3800	dre5	B-V.0	1973	293.6	19443	263	20.0	yes	no	no	no	no
74183.55c	181.3800	rmccsa	B-V.2	1980	293.6	79534	8083	20.0	yes	no	no	no	no
74183.55d	181.3800	drmcgs	B-V.2	1980	293.6	26320	263	20.0	yes	no	no	no	no
74183.60c	181.3800	endf60	B-VI.0	1980	293.6	89350	9131	20.0	yes	no	no	no	no
** W-184 **													
74184.49c	182.3700	ures	B-VI.0	1980	300.0	97118	9794	20.0	yes	no	no	no	yes
74184.50c	182.3700	endf5p	B-V.0	1973	293.6	58870	6173	20.0	yes	no	no	no	no
74184.50d	182.3700	dre5	B-V.0	1973	293.6	17032	263	20.0	yes	no	no	no	no
74184.55c	182.3700	rmccsa	B-V.2	1980	293.6	80006	7835	20.0	yes	no	no	no	no
74184.55d	182.3700	drmcgs	B-V.2	1980	293.6	26110	263	20.0	yes	no	no	no	no
74184.60c	182.3700	endf60	B-VI.0	1980	293.6	78809	7368	20.0	yes	no	no	no	no
** W-186 **													
74186.49c	184.3600	ures	B-VI.0	1980	300.0	102199	10485	20.0	yes	no	no	no	yes
74186.50c	184.3600	endf5p	B-V.0	1973	293.6	63701	6866	20.0	yes	no	no	no	no
74186.50d	184.3600	dre5	B-V.0	1973	293.6	17018	263	20.0	yes	no	no	no	no
74186.55c	184.3600	rmccsa	B-V.2	1980	293.6	83618	8342	20.0	yes	no	no	no	no
74186.55d	184.3600	drmcgs	B-V.2	1980	293.6	26281	263	20.0	yes	no	no	no	no
74186.60c	184.3600	endf60	B-VI.0	1980	293.6	82010	7793	20.0	yes	no	no	no	no
Z = 75 ***** Rhenium *****													
** Re-185 **													
75185.32c	183.3612	misc5xs[6]	LLNL	<1985	0.0	13650	1488	20.0	yes	no	no	no	no
75185.35c	183.3641	endl85	LLNL	<1985	0.0	16038	1487	20.0	yes	no	no	no	no
75185.42c	183.3641	endl92	LLNL	<1992	300.0	23715	2214	30.0	yes	no	no	no	no
75185.50c	183.3640	rmccsa	B-V.0	1968	293.6	9190	1168	20.0	no	no	no	no	no
75185.50d	183.3640	drmcgs	B-V.0	1968	293.6	4252	263	20.0	no	no	no	no	no
75185.60c	183.3640	endf60	B-VI.0	1990	293.6	102775	16719	20.0	no	no	no	no	no
** Re-187 **													
75187.32c	185.3539	misc5xs[6]	LLNL	<1985	0.0	12318	1296	20.0	yes	no	no	no	no
75187.35c	185.3497	endl85	LLNL	<1985	0.0	14769	1295	20.0	yes	no	no	no	no
75187.42c	185.3497	endl92	LLNL	<1992	300.0	20969	1821	30.0	yes	no	no	no	no
75187.50c	185.3500	rmccsa	B-V.0	1968	293.6	8262	959	20.0	no	no	no	no	no
75187.50d	185.3500	drmcgs	B-V.0	1968	293.6	4675	263	20.0	no	no	no	no	no
75187.60c	185.3500	endf60	B-VI.0	1990	293.6	96989	15624	20.0	no	no	no	no	no
Z = 77 ***** Iridium *****													
** Ir-nat **													
77000.55c	190.5630	misc5xs[6]	T-2	1986	300.0	43071	3704	20.0	no	no	no	no	no
** Ir-191 **													
77191.49c	189.3200	ures	B-VI.4	1995	300.0	83955	8976	20.0	yes	no	no	no	yes
** Ir-193 **													
77193.49c	191.3050	ures	B-VI.4	1995	300.0	82966	8943	20.0	yes	no	no	no	yes
Z = 78 ***** Platinum *****													
** pt-nat **													
78000.35c	193.4141	rmccsa	LLNL	<1985	0.0	15371	1497	20.0	yes	no	no	no	no
78000.35d	193.4141	drmcgs	LLNL	<1985	0.0	6933	263	20.0	yes	no	no	no	no
78000.40c	193.4141	endl92	LLNL	<1992	300.0	43559	5400	30.0	yes	no	no	no	no
78000.42c	193.4141	endl92	LLNL:X-5	<1992	300.0	43559	5400	30.0	yes	no	no	no	no
Z = 79 ***** Gold *****													
** Au-197 **													
79197.35c	195.2745	endl85	LLNL	<1985	0.0	31871	3781	20.0	yes	no	no	no	no
79197.50c	195.2740	endf5p	B-V.0	1977	293.6	139425	22632	20.0	no	no	no	no	no
79197.50d	195.2740	dre5	B-V.0	1977	293.6	4882	263	20.0	no	no	no	no	no
79197.55c	195.2740	rmccsa	T-2	1983[4]	293.6	134325	17909	20.0	yes	no	no	no	no
79197.55d	195.2740	drmcgs	T-2	1983[4]	293.6	7883	263	20.0	yes	no	no	no	no
79197.56c	195.2740	newxs	T-2	1984	293.6	122482	11823	30.0	yes	no	no	no	no

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**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
79197.56d	195.2740	newxsd	T-2	1984	293.6	38801	263	20.0	yes	no	no	no	no
79197.60c	195.2740	endf60	B-VI.1	1984	293.6	161039	17724	30.0	yes	no	no	no	no
Z = 80 ***** Mercury *****													
** Hg-nat **													
80000.40c	198.8668	endl92	LLNL	<1992	300.0	29731	2507	30.0	yes	no	no	no	no
80000.42c	198.8668	endl92	LLNL:X-5	<1992	300.0	29731	2507	30.0	yes	no	no	no	no
Z = 82 ***** Lead *****													
** Pb-nat **													
82000.35c	205.4200	endl85	LLNL	<1985	0.0	6639	349	20.0	yes	no	no	no	no
82000.42c	205.4200	endl92	LLNL	<1992	300.0	270244	18969	30.0	yes	no	no	no	no
82000.50c	205.4300	rmccs	B-V.0	1976	293.6	37633	1346	20.0	yes	no	no	no	no
82000.50d	205.4300	drmccs	B-V.0	1976	293.6	20649	263	20.0	yes	no	no	no	no
** Pb-206 **													
82206.60c	204.2000	endf60	B-VI.0	1989	293.6	148815	12872	20.0	yes	no	no	no	no
** Pb-207 **													
82207.60c	205.2000	endf60	B-VI.1	1991	293.6	111750	7524	20.0	yes	no	no	no	no
** Pb-208 **													
82208.60c	206.1900	endf60	B-VI.0	1989	293.6	70740	5105	20.0	yes	no	no	no	no
Z = 83 ***** Bismuth *****													
** Bi-209 **													
83209.35c	207.1851	endl85	LLNL	<1985	0.0	18316	1303	20.0	yes	no	no	no	no
83209.42c	207.1851	endl92	LLNL	<1992	300.0	20921	1200	30.0	yes	no	no	no	no
83209.50c	207.1850	endf5u	B-V.0	1980	293.6	14939	1300	20.0	yes	no	no	no	no
83209.50d	207.1850	dre5	B-V.0	1980	293.6	7516	263	20.0	yes	no	no	no	no
83209.51c	207.1850	rmccs	B-V.0	1980	293.6	13721	1186	20.0	yes	no	no	no	no
83209.51d	207.1850	drmccs	B-V.0	1980	293.6	7516	263	20.0	yes	no	no	no	no
83209.60c	207.1850	endf60	B-VI.0	1989	293.6	100138	8427	20.0	yes	no	no	no	no
Z = 90 ***** Thorium *****													
** Th-230 **													
90230.60c	228.0600	endf60	B-VI.0	1977	293.6	35155	5533	20.0	no	tot	no	no	no
** Th-231 **													
90231.35c	229.0516	endl85	LLNL	<1985	0.0	9157	308	20.0	yes	pr	no	no	no
90231.42c	229.0516	endl92	LLNL	<1992	300.0	15712	187	30.0	yes	both	no	no	no
** Th-232 **													
90232.35c	230.0447	endl85	LLNL	<1985	0.0	56091	6169	20.0	yes	pr	no	no	no
90232.42c	230.0447	endl92	LLNL	<1992	300.0	109829	13719	30.0	yes	both	no	no	no
90232.49c	230.0400	ures	B-VI.0	1977	300.0	305942	41414	20.0	yes	both	no	no	yes
90232.50c	230.0400	endf5u	B-V.0	1977	293.6	152782	17901	20.0	yes	both	no	no	no
90232.50d	230.0400	dre5	B-V.0	1977	293.6	11937	263	20.0	yes	both	no	no	no
90232.51c	230.0400	rmccs	B-V.0	1977	293.6	17925	1062	20.0	yes	both	no	no	no
90232.51d	230.0400	drmccs	B-V.0	1977	293.6	11937	263	20.0	yes	both	no	no	no
90232.60c	230.0400	endf60	B-VI.0	1977	293.6	127606	16381	20.0	yes	both	no	no	no
90232.61c	230.0400	endf6dn	B-VI.0	1977	293.6	132594	16381	20.0	yes	both	no	yes	no
** Th-233 **													
90233.35c	231.0396	endl85	LLNL	<1985	0.0	9352	348	20.0	yes	pr	no	no	no
90233.42c	231.0396	endl92	LLNL	<1992	300.0	16015	206	30.0	yes	both	no	no	no
Z = 91 ***** Protactinium *****													
** Pa-231 **													
91231.60c	229.0500	endf60	B-VI.0	1977	293.6	19835	2610	20.0	no	both	no	no	no
91231.61c	229.0500	endf6dn	B-VI.0	1977	293.6	24733	2610	20.0	no	both	no	yes	no
** Pa-233 **													
91233.35c	231.0383	endl85	LLNL	<1985	0.0	19170	1910	20.0	yes	pr	no	no	no
91233.42c	231.0383	endl92	LLNL	<1992	300.0	27720	1982	30.0	yes	both	no	no	no
91233.50c	231.0380	endf5u	B-V.0	1974	293.6	19519	2915	20.0	no	tot	no	no	no
91233.50d	231.0380	dre5	B-V.0	1974	293.6	3700	263	20.0	no	tot	no	no	no
91233.51c	231.0380	rmccs	B-V.0	1974	293.6	5641	637	20.0	no	tot	no	no	no

APPENDIX G  
MCNP NEUTRON CROSS-SECTION LIBRARIES

**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
91233.51d	231.0380	drmccs	B-V.0	1974	293.6	3700	263	20.0	no	tot	no	no	no
Z = 92 ***** Uranium *****													
** U-232 **													
92232.49c	230.0400	ures	B-VI.0	1977	300.0	21813	2820	20.0	no	both	no	no	yes
92232.60c	230.0400	endf60	B-VI.0	1977	293.6	13839	1759	20.0	no	both	no	no	no
92232.61c	230.0400	endf6dn	B-VI.0	1977	293.6	18734	1759	20.0	no	both	no	yes	no
** U-233 **													
92233.35c	231.0377	endl85	LLNL	<1985	0.0	29674	2924	20.0	yes	pr	no	no	no
92233.42c	231.0377	endl92	LLNL	<1992	300.0	29521	2163	30.0	yes	both	no	no	no
92233.49c	231.0430	ures	B-VI.0	1978	300.0	47100	4601	20.0	yes	both	no	no	yes
92233.50c	231.0430	rmccs	B-V.0	1978	293.6	18815	2293	20.0	no	both	no	no	no
92233.50d	231.0430	drmccs	B-V.0	1978	293.6	4172	263	20.0	no	both	no	no	no
92233.60c	231.0430	endl60[14]	B-VI.0	1978	293.6	32226	3223	20.0	yes	both	no	no	no
92233.61c	231.0430	endf6dn	B-VI.0	1978	293.6	37218	3223	20.0	yes	both	no	yes	no
** U-234 **													
92234.35c	232.0304	endl85	LLNL	<1985	0.0	8557	237	20.0	yes	pr	no	no	no
92234.42c	232.0304	endl92	LLNL	<1992	300.0	13677	149	30.0	yes	both	no	no	no
92234.49c	232.0300	ures	B-VI.0	1978	300.0	161296	22539	20.0	no	both	no	no	yes
92234.50c	232.0300	endf5p	B-V.0	1978	293.6	89433	12430	20.0	no	tot	no	no	no
92234.50d	232.0300	dre5	B-V.0	1978	293.6	4833	263	20.0	no	tot	no	no	no
92234.51c	232.0300	rmccs	B-V.0	1978	293.6	6426	672	20.0	no	tot	no	no	no
92234.51d	232.0300	drmccs	B-V.0	1978	293.6	4833	263	20.0	no	tot	no	no	no
92234.60c	232.0300	endl60	B-VI.0	1978	293.6	77059	10660	17.5	no	both	no	no	no
92234.61c	232.0300	endf6dn	B-VI.0	1978	293.6	82047	10660	17.5	no	both	no	yes	no
** U-235 **,													
92235.01c	233.0250	endfht	B-VI.2	1989	1.2e4	234381	18913	20.0	yes	both	no	no	no
92235.02c	233.0250	endfht	B-V.2	1989	1.2e5	138369	8245	20.0	yes	both	no	no	no
92235.03c	233.0250	endfht	B-VI.2	1989	1.2e6	102567	4267	20.0	yes	both	no	no	no
92235.04c	233.0250	endfht	B-VI.2	1989	1.2e7	85917	2417	20.0	yes	both	no	no	no
92235.05c	233.0250	endfht	B-VI.2	1989	1.2e8	79635	1719	20.0	yes	both	no	no	no
92235.06c	233.0250	endfht	B-V.0	1977	1.2e4	47562	3712	20.0	yes	both	no	no	no
92235.07c	233.0250	endfht	B-V.0	1977	1.2e5	32721	2063	20.0	yes	both	no	no	no
92235.08c	233.0250	endfht	B-V.0	1977	1.2e6	28905	1639	20.0	yes	both	no	no	no
92235.09c	233.0250	endfht	B-V.0	1977	1.2e7	27627	1497	20.0	yes	both	no	no	no
92235.10c	233.0250	endfht	B-V.0	1977	1.2e8	27312	1462	20.0	yes	both	no	no	no
92235.11c	233.0250	endf62mt[15]	B-VI.2	1989	77.0	696398	78912	20.0	yes	both	no	no	no
92235.12c	233.0250	endf62mt[15]	B-VI.2	1989	400.0	411854	43344	20.0	yes	both	no	no	no
92235.13c	233.0250	endf62mt[15]	B-VI.2	1989	500.0	379726	39328	20.0	yes	both	no	no	no
92235.14c	233.0250	endf62mt[15]	B-VI.2	1989	600.0	353678	36072	20.0	yes	both	no	no	no
92235.15c	233.0250	endf62mt[15]	B-VI.2	1989	800.0	316622	31440	20.0	yes	both	no	no	no
92235.16c	233.0250	endf62mt[15]	B-VI.2	1989	900.0	300278	29397	20.0	yes	both	no	no	no
92235.17c	233.0250	endf62mt[15]	B-VI.2	1989	1200	269062	25495	20	yes	both	no	no	no
92235.42c	233.0248	endl92	LLNL	<1992	300.0	72790	5734	30.0	yes	both	no	no	no
92235.49c	233.0250	ures	B-VI.4	1996	300.0	647347	72649	20.0	yes	both	no	no	yes
92235.50c	233.0250	rmccs	B-V.0	1977	293.6	60489	5725	20.0	yes	both	no	no	no
92235.50d	233.0250	drmccs	B-V.0	1977	293.6	11788	263	20.0	yes	both	no	no	no
92235.52c	233.0250	endf5mt[1]	B-V.0	1977	587.2	65286	6320	20.0	yes	both	no	no	no
92235.53c	233.0250	endf5mt[1]	B-V.0	1977	587.2	36120	2685	20.0	yes	both	no	no	no
92235.54c	233.0250	endf5mt[1]	B-V.0	1977	880.8	36008	2671	20.0	yes	both	no	no	no
92235.56c	233.0250	endf5ht	B-V.0	1977	1.2e4	28494	1729	20.0	yes	both	no	no	no
92235.57c	233.0250	endf5ht	B-V.0	1977	1.2e5	25214	1319	20.0	yes	both	no	no	no
92235.58c	233.0250	endf5ht	B-V.0	1977	1.2e6	22966	1038	20.0	yes	both	no	no	no
92235.59c	233.0250	endf5ht	B-V.0	1977	1.2e7	22406	968	20.0	yes	both	no	no	no
92235.60c	233.0250	endl60	B-VI.2	1989	293.6	289975	28110	20.0	yes	both	no	no	no
92235.61c	233.0250	endf6dn	B-VI.2	1989	293.6	294963	28110	20.0	yes	both	no	yes	no
** U-236 **													
92236.35c	234.0178	endl85	LLNL	<1985	0.0	8699	224	20.0	yes	pr	no	no	no
92236.42c	234.0178	endl92	LLNL	<1992	300.0	14595	311	30.0	yes	both	no	no	no
92236.49c	234.0180	ures	B-VI.0	1989	300.0	159074	20865	20.0	no	both	no	no	yes
92236.50c	234.0180	endf5p	B-V.0	1978	293.6	138715	19473	20.0	no	tot	no	no	no
92236.50d	234.0180	dre5	B-V.0	1978	293.6	4838	263	20.0	no	tot	no	no	no
92236.51c	234.0180	rmccs	B-V.0	1978	293.6	7302	800	20.0	no	tot	no	no	no
92236.51d	234.0180	drmccs	B-V.0	1978	293.6	4838	263	20.0	no	tot	no	no	no
92236.60c	234.0180	endl60	B-VI.0	1989	293.6	82819	10454	20.0	no	both	no	no	no

**APPENDIX G**  
**MCNP NEUTRON CROSS-SECTION LIBRARIES**

**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
92236.61c ** U-237 **	234.0180	endf6dn	B-VI.0	1989	293.6	87807	10454	20.0	no	both	no	yes	no
92237.35c	235.0123	endl85	LLNL	<1985	0.0	9364	353	20.0	yes	pr	no	no	no
92237.42c	235.0123	endl92	LLNL	<1992	300.0	13465	210	30.0	yes	both	no	no	no
92237.50c	235.0120	endf5p	B-V.0	1976	293.6	32445	3293	20.0	yes	tot	no	no	no
92237.50d	235.0120	dre5	B-V.0	1976	293.6	8851	263	20.0	yes	tot	no	no	no
92237.51c	235.0120	rmccs	B-V.0	1976	293.6	10317	527	20.0	yes	tot	no	no	no
92237.51d	235.0120	drmccs	B-V.0	1976	293.6	8851	263	20.0	yes	tot	no	no	no
** U-238 **													
92238.01c	236.0060	endfht	B-VI.2	1993	1.2e4	296788	30203	20.0	yes	both	no	no	no
92238.02c	236.0060	endfht	B-VI.2	1993	1.2e5	138937	12664	20.0	yes	both	no	no	no
92238.03c	236.0060	endfht	B-VI.2	1993	1.2e6	77638	5853	20.0	yes	both	no	no	no
92238.04c	236.0060	endfht	B-VI.2	1993	1.2e7	54625	3296	20.0	yes	both	no	no	no
92238.05c	236.0060	endfht	B-VI.2	1993	1.2e8	44356	2155	20.0	yes	both	no	no	no
92238.06c	236.0060	endfht	B-V.0	1979	1.2e4	185164	18732	20.0	yes	both	no	no	no
92238.07c	236.0060	endfht	B-V.0	1979	1.2e5	85705	7681	20.0	yes	both	no	no	no
92238.08c	236.0060	endfht	B-V.0	1979	1.2e6	46123	3283	20.0	yes	both	no	no	no
92238.09c	236.0060	endfht	B-V.0	1979	1.2e7	34774	2022	20.0	yes	both	no	no	no
92238.10c	236.0060	endfht	B-V.0	1979	1.2e8	30193	1513	20.0	yes	both	no	no	no
92238.11c	236.0060	endf62mt[15]	B-VI.2	1993	77.0	621385	74481	20.0	yes	both	no	no	no
92238.12c	236.0060	endf62mt[15]	B-VI.2	1993	400.0	456593	53882	20.0	yes	both	no	no	no
92238.13c	236.0060	endf62mt[15]	B-VI.2	1993	500.0	433681	51018	20.0	yes	both	no	no	no
92238.14c	236.0060	endf62mt[15]	B-VI.2	1993	600.0	414185	48581	20.0	yes	both	no	no	no
92238.15c	236.0060	endf62mt[15]	B-VI.2	1993	800.0	386305	45096	20.0	yes	both	no	no	no
92238.16c	236.0060	endf62mt[15]	B-VI.2	1993	900.0	372625	43386	20.0	yes	both	no	no	no
92238.17c	236.0060	endf62mt[15]	B-VI.2	1993	1200.0	348137	40325	20.0	yes	both	no	no	no
92238.21c	236.0060	100xs[3]	T-2:X-5	1989	300.0	279245	30911	100.0	yes	both	no	no	no
92238.35c	236.0058	endl85	LLNL	<1985	0.0	27168	1845	20.0	yes	pr	no	no	no
92238.42c	236.0058	endl92	LLNL	<1992	300.0	107739	7477	30.0	yes	both	no	no	no
92238.49c	236.0060	ures	B-VI.2	1993	300.0	705623	85021	20.0	yes	both	no	yes	no
92238.50c	236.0060	rmccs	B-V.0	1979	293.6	88998	9285	20.0	yes	both	no	no	no
92238.50d	236.0060	drmccs	B-V.0	1979	293.6	16815	263	20.0	yes	both	no	no	no
92238.52c	236.0060	endf5mt[1]	B-V.0	1979	587.2	123199	8454	20.0	yes	both	no	no	no
92238.53c	236.0060	endf5mt[1]	B-V.0	1979	587.2	160107	17876	20.0	yes	both	no	no	no
92238.54c	236.0060	endf5mt[1]	B-V.0	1979	880.8	160971	17984	20.0	yes	both	no	no	no
92238.56c	233.0250	endf5ht	B-V.0	1979	1.2e4	82470	8176	20.0	yes	both	no	no	no
92238.57c	233.0250	endf5ht	B-V.0	1979	1.2e5	47206	3768	20.0	yes	both	no	no	no
92238.58c	233.0250	endf5ht	B-V.0	1979	1.2e6	27814	1344	20.0	yes	both	no	no	no
92238.59c	233.0250	endf5ht	B-V.0	1979	1.2e7	22078	627	20.0	yes	both	no	no	no
92238.60c	236.0060	endf60	B-VI.2	1993	293.6	206322	22600	20.0	yes	both	no	no	no
92238.61c	236.0060	endf6dn	B-VI.2	1993	293.6	211310	22600	20.0	yes	both	no	yes	no
** U-239 **													
92239.35c	237.0007	rmccsa	LLNL	<1985	0.0	9809	394	20.0	yes	pr	no	no	no
92239.35d	237.0007	drmccs	LLNL	<1985	0.0	9286	263	20.0	yes	pr	no	no	no
92239.42c	237.0007	endl92	LLNL	<1992	300.0	14336	205	30.0	yes	both	no	no	no
** U-240 **													
92240.35c	237.9944	endl85	LLNL	<1985	0.0	8495	218	20.0	yes	pr	no	no	no
92240.42c	237.9944	endl92	LLNL	<1992	300.0	14000	128	30.0	yes	both	no	no	no
Z = 93 ***** Neptunium *****													
** Np-235 **													
93235.35c	233.0249	endl85	LLNL	<1985	0.0	9490	364	20.0	yes	pr	no	no	no
93235.42c	233.0249	endl92	LLNL	<1992	300.0	17717	660	30.0	yes	both	no	no	no
** Np-236 **													
93236.35c	234.0188	endl85	LLNL	<1985	0.0	8821	284	20.0	yes	pr	no	no	no
93236.42c	234.0188	endl92	LLNL	<1992	300.0	13464	179	30.0	yes	both	no	no	no
** Np-237 **													
93237.35c	235.0118	endl85	LLNL	<1985	0.0	20225	1678	20.0	yes	pr	no	no	no
93237.42c	235.0118	endl92	LLNL	<1992	300.0	31966	2477	30.0	yes	both	no	no	no
93237.50c	235.0120	endf5p	B-V.0	1978	293.6	63223	8519	20.0	no	tot	no	no	no
93237.50d	235.0120	dre5	B-V.0	1978	293.6	5267	263	20.0	no	tot	no	no	no
93237.55c	235.0120	rmccsa	T-2	1984	293.6	32558	1682	20.0	no	both	no	no	no
93237.55d	235.0120	drmccs	T-2	1984	293.6	20484	263	20.0	no	both	no	no	no
93237.60c	235.0118	endf60	B-VI.1	1990	293.6	105150	7218	20.0	yes	both	no	no	no
93237.61c	235.0118	endf6dn	B-VI.1	1990	293.6	110048	7218	20.0	yes	both	no	yes	no

APPENDIX G  
MCNP NEUTRON CROSS-SECTION LIBRARIES

**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
<b>** Np-238 **</b>													
93238.35c	236.0060	endl85	LLNL	<1985	0.0	8878	282	20.0	yes	pr	no	no	no
93238.42c	236.0060	endl92	LLNL	<1992	300.0	13445	165	30.0	yes	both	no	no	no
<b>** Np-239 **</b>													
93239.60c	236.9990	endf60	B-VI.0	1988	293.6	7406	562	20.0	no	tot	no	no	no
Z = 94 ***** Plutonium *****													
<b>** Pu-236 **</b>													
94236.60c	234.0180	endf60	B-VI.0	1978	293.6	33448	4610	20.0	no	tot	no	no	no
<b>** Pu-237 **</b>													
94237.35c	235.0120	endl85	LLNL	<1985	0.0	11300	202	20.0	yes	pr	no	no	no
94237.42c	235.0120	endl92	LLNL	<1992	300.0	17284	279	30.0	yes	both	no	no	no
94237.60c	235.0120	endf60	B-VI.0	1978	293.6	3524	257	20.0	no	tot	no	no	no
<b>** Pu-238 **</b>													
94238.35c	236.0046	endl85	LLNL	<1985	0.0	15619	958	20.0	yes	pr	no	no	no
94238.42c	236.0046	endl92	LLNL	<1992	300.0	30572	2177	30.0	yes	both	no	no	no
94238.49c	236.0045	ures	B-VI.0	1978	300.0	41814	5337	20.0	no	both	no	no	yes
94238.50c	236.1670	endf5p	B-V.0	1978	293.6	18763	2301	20.0	no	tot	no	no	no
94238.50d	236.1670	dre5	B-V.0	1978	293.6	5404	263	20.0	no	tot	no	no	no
94238.51c	236.1670	rmccs	B-V.0	1978	293.6	6067	537	20.0	no	tot	no	no	no
94238.51d	236.1670	drmccts	B-V.0	1978	293.6	5404	263	20.0	no	tot	no	no	no
94238.60c	236.0045	endf60	B-VI.0	1978	293.6	29054	3753	20.0	no	both	no	no	no
94238.61c	236.0045	endf6dn	B-VI.0	1978	293.6	33952	3753	20.0	no	both	no	yes	no
<b>** Pu-239 **</b>													
94239.01c	236.9986	endfht	B-VI.2	1993	1.2e4	229878	18004	20.0	yes	both	no	no	no
94239.02c	236.9986	endfht	B-VI.2	1993	1.2e5	126018	6464	20.0	yes	both	no	no	no
94239.03c	236.9986	endfht	B-VI.2	1993	1.2e6	97362	3280	20.0	yes	both	no	no	no
94239.04c	236.9986	endfht	B-VI.2	1993	1.2e7	85788	1994	20.0	yes	both	no	no	no
94239.05c	236.9986	endfht	B-VI.2	1993	1.2e8	81423	1509	20.0	yes	both	no	no	no
94239.06c	236.9990	endfht	B-V.2	1983	1.2e4	76790	6005	20.0	yes	both	no	no	no
94239.07c	236.9990	endfht	B-V.2	1983	1.2e5	45461	2524	20.0	yes	both	no	no	no
94239.08c	236.9990	endfht	B-V.2	1983	1.2e6	36236	1499	20.0	yes	both	no	no	no
94239.09c	236.9990	endfht	B-V.2	1983	1.2e7	33797	1228	20.0	yes	both	no	no	no
94239.10c	236.9990	endfht	B-V.2	1983	1.2e8	33230	1165	20.0	yes	both	no	no	no
94239.11c	236.9986	endf62mt[15]	B-VI.2	1993	77.0	568756	62522	20.0	yes	both	no	no	no
94239.12c	236.9986	endf62mt[15]	B-VI.2	1993	400.0	418556	43747	20.0	yes	both	no	no	no
94239.13c	236.9986	endf62mt[15]	B-VI.2	1993	500.0	395964	40923	20.0	yes	both	no	no	no
94239.14c	236.9986	endf62mt[15]	B-VI.2	1993	600.0	377116	38567	20.0	yes	both	no	no	no
94239.15c	236.9986	endf62mt[15]	B-VI.2	1993	800.0	350292	35214	20.0	yes	both	no	no	no
94239.16c	236.9986	endf62mt[15]	B-VI.2	1993	900.0	338236	33707	20.0	yes	both	no	no	no
94239.17c	236.9986	endf62mt[15]	B-VI.2	1993	1200.0	312572	30499	20	yes	both	no	no	no
94239.42c	236.9986	endl92	LLNL	<1992	300.0	93878	6827	30.0	yes	both	no	no	no
94239.49c	236.9986	ures	B-VI.2	1993	300.0	595005	64841	20.0	yes	both	no	no	yes
94239.50c	236.9990	endf5p	B-V.0	1976	293.6	74049	7809	20.0	yes	both	no	no	no
94239.50d	236.9990	dre5	B-V.0	1976	293.6	12631	263	20.0	yes	both	no	no	no
94239.55c	236.9990	rmccs	B-V.2	1983	293.6	102099	10318	20.0	yes	both	no	no	no
94239.55d	236.9990	drmccts	B-V.2	1983	293.6	20727	263	20.0	yes	both	no	no	no
94239.56c	236.9990	endf5ht	B-V.2	1983	1.2e4	45529	2547	20.0	yes	both	no	no	no
94239.57c	236.9990	endf5ht	B-V.2	1983	1.2e5	36201	1381	20.0	yes	both	no	no	no
94239.58c	236.9990	endf5ht	B-V.2	1983	1.2e6	31049	737	20.0	yes	both	no	no	no
94239.59c	236.9990	endf5ht	B-V.2	1983	1.2e7	29761	576	20.0	yes	both	no	no	no
94239.60c	236.9986	endf60	B-VI.2	1993	293.6	283354	26847	20.0	yes	both	no	no	no
94239.61c	236.9986	endf6dn	B-VI.2	1993	293.6	288252	26847	20.0	yes	both	no	yes	no
<b>** Pu-240 **</b>													
94240.42c	237.9916	endl92	LLNL	<1992	300.0	198041	16626	30.0	yes	both	no	no	no
94240.49c	237.9920	ures	B-VI.2	1986	300.0	341542	41596	20.0	yes	both	no	no	yes
94240.50c	237.9920	rmccs	B-V.0	1977	293.6	58917	6549	20.0	yes	both	no	no	no
94240.50d	237.9920	drmccts	B-V.0	1977	293.6	9569	263	20.0	yes	both	no	no	no
94240.60c	237.9920	endf60	B-VI.2	1986	293.6	133071	15676	20.0	yes	both	no	no	no
94240.61c	237.9920	endf6dn	B-VI.2	1986	293.6	137969	15676	20.0	yes	both	no	yes	no
<b>** Pu-241 **</b>													
94241.35c	238.9860	endl85	LLNL	<1985	0.0	8844	257	20.0	yes	pr	no	no	no
94241.42c	238.9860	endl92	LLNL	<1992	300.0	14108	203	30.0	yes	both	no	no	no
94241.49c	238.9780	ures	B-VI.3	1994	300.0	155886	17753	20.0	yes	both	no	no	yes
94241.50c	238.9780	endf5p	B-V.0	1977	293.6	38601	3744	20.0	yes	both	no	no	no

**APPENDIX G**  
**MCNP NEUTRON CROSS-SECTION LIBRARIES**

**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library Name	Source	Eval Date	Temp (°K)	Length words	NE	E <sub>max</sub> MeV	GPD	Ū	CP	DN	UR
94241.50d	238.9780	dre5	B-V.0	1977	293.6	11575	263	20.0	yes	both	no	no	no
94241.51c	238.9780	rmccs	B-V.0	1977	293.6	13403	623	20.0	yes	both	no	no	no
94241.51d	238.9780	drmccs	B-V.0	1977	293.6	11575	263	20.0	yes	both	no	no	no
94241.60c	238.9780	endf60	B-VI.1	1988	293.6	76453	8112	20.0	yes	both	no	no	no
94241.61c	238.9780	endf6dn	B-VI.1	1988	293.6	81351	8112	20.0	yes	both	no	yes	no
** Pu-242 **													
94242.35c	239.9793	endl85	LLNL	<1985	0.0	21159	1724	20.0	yes	pr	no	no	no
94242.42c	239.9793	endl92	LLNL	<1992	300.0	48688	4287	30.0	yes	both	no	no	no
94242.49c	239.9790	ures	B-VI.0	1978	300.0	130202	14922	20.0	yes	both	no	no	yes
94242.50c	239.9790	endlf5p	B-V.0	1978	293.6	71429	7636	20.0	yes	both	no	no	no
94242.50d	239.9790	dre5	B-V.0	1978	293.6	12463	263	20.0	yes	both	no	no	no
94242.51c	239.9790	rmccs	B-V.0	1978	293.6	15702	728	20.0	yes	both	no	no	no
94242.51d	239.9790	drmccs	B-V.0	1978	293.6	12463	263	20.0	yes	both	no	no	no
94242.60c	239.9790	endf60	B-VI.0	1978	293.6	73725	7896	20.0	yes	both	no	no	no
94242.61c	239.9790	endf6dn	B-VI.0	1978	293.6	78623	7896	20.0	yes	both	no	yes	no
** Pu-243 **													
94243.35c	240.9740	endl85	LLNL	<1985	0.0	10763	485	20.0	yes	pr	no	no	no
94243.42c	240.9740	endl92	LLNL	<1992	300.0	20253	745	30.0	yes	both	no	no	no
94243.60c	240.9740	endf60	B-VI.2	1976	293.6	45142	4452	20.0	yes	tot	no	no	no
** Pu-244 **													
94244.60c	241.9680	endf60	B-VI.0	1978	293.6	23654	3695	20.0	no	tot	no	no	no
Z = 95 ***** Americium *****													
** Am-241 **													
95241.35c	238.9860	endl85	LLNL	<1985	0.0	25290	1982	20.0	yes	pr	no	no	no
95241.42c	238.9860	endl92	LLNL	<1992	300.0	32579	2011	30.0	yes	both	no	no	no
95241.50c	238.9860	endlf5u	B-V.0	1978	293.6	42084	4420	20.0	yes	tot	no	no	no
95241.50d	238.9860	dre5	B-V.0	1978	293.6	9971	263	20.0	yes	tot	no	no	no
95241.51c	238.9860	rmccs	B-V.0	1978	293.6	12374	713	20.0	yes	tot	no	no	no
95241.51d	238.9860	drmccs	B-V.0	1978	293.6	9971	263	20.0	yes	tot	no	no	no
95241.60c	238.9860	endf60	T-2	1994	300.0	168924	13556	30.0	yes	both	no	no	no
95241.61c	238.9860	endf6dn	T-2	1994	300.0	173822	13556	30.0	yes	both	no	yes	no
** Am-242 ms **													
95242.35c	239.9801	endl85	LLNL	<1985	0.0	20908	1817	20.0	yes	pr	no	no	no
95242.42c	239.9801	endl92	LLNL	<1992	300.0	21828	1368	20.0	yes	both	no	no	no
95242.50c	239.9800	endlf5u	B-V.0	1978	293.6	8593	323	20.0	yes	tot	no	no	no
95242.50d	239.9800	dre5	B-V.0	1978	293.6	9048	263	20.0	yes	tot	no	no	no
95242.51c	239.9800	rmccs	B-V.0	1978	293.6	8502	317	20.0	yes	tot	no	no	no
95242.51d	239.9800	drmccs	B-V.0	1978	293.6	9048	263	20.0	yes	tot	no	no	no
** Am-243 **													
95243.35c	240.9733	endl85	LLNL	<1985	0.0	39400	4093	20.0	yes	pr	no	no	no
95243.42c	240.9733	endl92	LLNL	<1992	300.0	52074	4867	30.0	yes	both	no	no	no
95243.50c	240.9730	endlf5u	B-V.0	1978	293.6	92015	11921	20.0	yes	tot	no	no	no
95243.50d	240.9730	dre5	B-V.0	1978	293.6	11742	263	20.0	yes	tot	no	no	no
95243.51c	240.9730	rmccs	B-V.0	1978	293.6	13684	757	20.0	yes	tot	no	no	no
95243.51d	240.9730	drmccs	B-V.0	1978	293.6	11742	263	20.0	yes	tot	no	no	no
95243.60c	240.9730	endf60	B-VI.0	1988	293.6	104257	11984	20.0	yes	both	no	no	no
95243.61c	240.9730	endf6dn	B-VI.0	1988	293.6	109155	11984	20.0	yes	both	no	yes	no
Z = 96 ***** Curium *****													
** Cm-241 **													
96241.60c	238.9870	endf60	B-VI.0	1978	293.6	3132	278	20.0	no	tot	no	no	no
** Cm-242 **													
96242.35c	239.9794	endl85	LLNL	<1985	0.0	21653	1891	20.0	yes	pr	no	no	no
96242.42c	239.9794	endl92	LLNL	<1992	300.0	37766	3141	30.0	yes	both	no	no	no
96242.50c	239.9790	endlf5u	B-V.0	1978	293.6	30897	3113	20.0	yes	tot	no	no	no
96242.50d	239.9790	dre5	B-V.0	1978	293.6	8903	263	20.0	yes	tot	no	no	no
96242.51c	239.9790	rmccs	B-V.0	1978	293.6	9767	472	20.0	yes	tot	no	no	no
96242.51d	239.9790	drmccs	B-V.0	1978	293.6	8903	263	20.0	yes	tot	no	no	no
96242.60c	239.9790	endf60	B-VI.0	1978	293.6	34374	3544	20.0	yes	both	no	no	no
96242.61c	239.9790	endf6dn	B-VI.0	1978	293.6	39269	3544	20.0	yes	both	no	yes	no
** Cm-243 **													
96243.35c	240.9733	endl85	LLNL	<1985	0.0	21577	1880	20.0	yes	pr	no	no	no
96243.42c	240.9733	endl92	LLNL	<1992	300.0	21543	1099	30.0	yes	both	no	no	no

**APPENDIX G**  
**MCNP NEUTRON CROSS-SECTION LIBRARIES**

**TABLE G-2 (Cont.)**  
**Continuous-Energy and Discrete Neutron Data Libraries Maintained by X-5**

ZAID	AWR	Library		Eval Date	Temp (°K)	Length words	E <sub>max</sub>			$\bar{V}$	CP	DN	UR
		Name	Source				NE	MeV	GPD				
96243.60c	240.9730	endf60	B-VI.0	1978	293.6	18860	1445	20.0	yes	tot	no	no	no
** Cm-244 **													
96244.35c	241.9661	endl85	LLNL	<1985	0.0	21196	1815	20.0	yes	pr	no	no	no
96244.42c	241.9661	endl92	LLNL	<1992	300.0	46590	4198	30.0	yes	both	no	no	no
96244.49c	241.9660	ures	B-VI.0	1978	300.0	97975	11389	20.0	yes	pr	no	no	yes
96244.50c	241.9660	endl5u	B-V.0	1978	293.6	45991	4919	20.0	yes	tot	no	no	no
96244.50d	241.9660	dre5	B-V.0	1978	293.6	9509	263	20.0	yes	tot	no	no	no
96244.51c	241.9660	rmccs	B-V.0	1978	293.6	10847	566	20.0	yes	tot	no	no	no
96244.51d	241.9660	drmccs	B-V.0	1978	293.6	9509	263	20.0	yes	tot	no	no	no
96244.60c	241.9660	endl60	B-VI.0	1978	293.6	73001	8294	20.0	yes	tot	no	no	no
** Cm-245 **													
96245.35c	242.9602	endl85	LLNL	<1985	0.0	24128	2230	20.0	yes	pr	no	no	no
96245.42c	242.9602	endl92	LLNL	<1992	300.0	25678	1564	30.0	yes	both	no	no	no
96245.60c	242.9600	endl60	B-VI.2	1979	293.6	29535	2636	20.0	yes	both	no	no	no
96245.61c	242.9600	endlf6dn	B-VI.2	1979	293.6	34433	2636	20.0	yes	both	no	yes	no
** Cm-246 **													
96246.35c	243.9534	endl85	LLNL	<1985	0.0	12489	711	20.0	yes	pr	no	no	no
96246.42c	243.9534	endl92	LLNL	<1992	300.0	24550	1376	30.0	yes	both	no	no	no
96246.60c	243.9530	endf60	B-VI.2	1976	293.6	37948	3311	20.0	yes	tot	no	no	no
** Cm-247 **													
96247.35c	244.9479	endl85	LLNL	<1985	0.0	20265	1654	20.0	yes	pr	no	no	no
96247.42c	244.9479	endl92	LLNL	<1992	300.0	39971	3256	30.0	yes	both	no	no	no
96247.60c	244.9500	endf60	B-VI.2	1976	293.6	38800	3679	20.0	yes	tot	no	no	no
** Cm-248 **													
96248.35c	245.9413	endl85	LLNL	<1985	0.0	18178	1425	20.0	yes	pr	no	no	no
96248.42c	245.9413	endl92	LLNL	<1992	300.0	40345	3355	30.0	yes	both	no	no	no
96248.60c	245.9410	endf60	B-VI.0	1978	293.6	83452	9706	20.0	yes	tot	no	no	no
Z = 97 ***** Berkelium *****													
** Bk-249 **													
97249.35c	246.9353	endl85	LLNL	<1985	0.0	11783	633	20.0	yes	pr	no	no	no
97249.42c	246.9353	endl92	LLNL	<1992	300.0	19573	809	30.0	yes	both	no	no	no
97249.60c	246.9400	endf60	B-VI:X-5	1986	293.6	50503	5268	20.0	no	both	no	no	no
Z = 98 ***** Californium *****													
** Cf-249 **													
98249.35c	246.9352	endl85	LLNL	<1985	0.0	28055	2659	20.0	yes	pr	no	no	no
98249.42c	246.9352	endl92	LLNL	<1992	300.0	49615	4554	30.0	yes	both	no	no	no
98249.60c	246.9400	endl60	B-VI:X-5	1989	293.6	41271	4329	20	no	both	no	no	no
98249.61c	246.9400	endlf6dn	B-VI:X-5	1989	293.6	46154	4329	20.0	no	both	no	yes	no
** Cf-250 **													
98250.35c	247.9281	endl85	LLNL	<1985	0.0	10487	457	20.0	yes	pr	no	no	no
98250.42c	247.9281	endl92	LLNL	<1992	300.0	17659	574	30.0	yes	both	no	no	no
98250.60c	247.9280	endf60	B-VI.2	1976	293.6	47758	5554	20.0	yes	tot	no	no	no
** Cf-251 **													
98251.35c	248.9227	endl85	LLNL	<1985	0.0	10969	516	20.0	yes	pr	no	no	no
98251.42c	248.9227	endl92	LLNL	<1992	300.0	17673	545	30.0	yes	both	no	no	no
98251.60c	248.9230	endl60	B-VI.2	1976	293.6	42817	4226	20.0	yes	both	no	no	no
98251.61c	248.9230	endlf6dn	B-VI.2	1976	293.6	47715	4226	20.0	yes	both	no	yes	no
** Cf-252 **													
98252.35c	249.9161	endl85	LLNL	<1985	0.0	17908	1535	20.0	yes	pr	no	no	no
98252.42c	249.9161	endl92	LLNL	<1992	300.0	21027	1210	30.0	yes	both	no	no	no
98252.60c	249.9160	endf60	B-VI.2	1976	293.6	49204	5250	20.0	yes	both	no	no	no

**Not all libraries listed in this table are publically available.**

## APPENDIX G

### MCNP NEUTRON CROSS-SECTION LIBRARIES

#### SPECIAL NOTES

- note 1. The data libraries previously known as EPRIXS and U600K are now a part of the data library ENDF5MT.
- note 2. Data translated to ENDF/B-VI format with some modifications by LANL.
- note 3. The 100XS data library contains data for 9 nuclides up to 100 MeV. Heating numbers on this data library are known to be incorrect, overestimating the energy deposition.<sup>4</sup>
- note 4. Photon production data were added to the existing ENDF evaluation in 1984. A complete new evaluation was performed in 1986.
- note 5. The natural carbon data 6000.50c are repeated here with the ZAID of 6012.50c for the user's convenience. Both are based on the natural carbon ENDF/B-V.0 evaluation.
- note 6. The data libraries previously known as ARKRC, GDT2GP, IRNAT, MISCXS, TM169, and T2DDC are now a part of the data library MISC5XS.
- note 7. Photon production added to ENDF/B-V.0 neutron files by T-2, with the intent to estimate photon heating roughly.<sup>5</sup>
- note 8. These data were taken from incomplete fission-product evaluations.<sup>6</sup>
- note 9. This is ENDF/B-V.0 after modification by evaluator to get better agreement with ENDL85.<sup>7,8</sup>
- note 10. The following files for Zr have been replaced by the indicated ZAID, eliminating the rare problem of having a secondary neutron energy greater than the incident neutron energy caused by an ENDF/B-V.0 evaluation problem.<sup>9</sup> Note that this correction has been made for the ENDF/B-VI evaluation.

40000.50c	rmccs	->	40000.56c	misc5xs
40000.50d	drmccs	->	40000.56d	misc5xs
40000.51c	endf5p	->	40000.57c	misc5xs
40000.51d	dre5	->	40000.57d	misc5xs
40000.53c	eprixs	->	40000.58c	misc5xs

- note 11. The ZAIDs for ENDL-based average fission product data files have been changed for the latest library, ENDL92, to 49120.42c and 49125.42c. Z is now set to 49 to ensure that the appropriate atomic fraction and photon transport library is used. You may need to update the atomic weight ratio table in your XSDIR file to include these entries.<sup>10,11</sup> The ENDL92FP library is not publically available.
- note 12. The LANL/T-2 evaluation for I-127 was accepted for ENDF/B-VI.2 with modifications. These data are processed from the original LANL/T-2 evaluation.
- note 13. Photon production data for Gd were added to the ENDF/B-V.0 neutron cross sections by T-2. These data are valid only to 1 MeV.<sup>12</sup>
- note 14. Photon production data added to original evaluation in 1981 by LANL.
- note 15. The multitemperature data library ENDF62MT is still under development and is not publically available.<sup>13</sup>

**APPENDIX G**  
**MULTIGROUP DATA FOR MCNP**

**IV. MULTIGROUP DATA FOR MCNP**

Currently, only one coupled neutron-photon multigroup library is supported by X-5, MGXSNP.<sup>14</sup> MGXSNP is comprised of 30-group neutron and 12-group photon data primarily based on ENDF/B-V for 95 nuclides. The MCNP-compatible multigroup data library was produced from the original Sn multigroup libraries MENDF5 and MENDF5G using the code CRSRD in April 1987.<sup>15,16</sup> The original neutron data library MENDF5 was produced using the “TD-Division Weight Function,” also called “CLAW” by the processing code NJOY.<sup>17,18,19</sup> This weight function is a combination of a Maxwellian thermal + 1/E + fission + fusion peak at 14.0 MeV. The data library contains no upscatter groups or self-shielding, and is most applicable for fast systems. All cross-sections are for room temperature, 300°K. P0 through P4 scattering matrices from the original library were processed by CRSRD into angular distributions for MCNP using the Carter-Forest equiprobable bin treatment. When available, both total and prompt nubar data are provided. The edit reactions available for each ZAID are fully described in reference 14.

TABLE G-3 describes the MGXSNP data library. The ZAIDs used for this library correspond to the source evaluation in the same manner as the ZAID for the continuous-energy and discrete data; as an example the same source evaluation for natural iron was used to produce 26000.55c, 26000.55d and 26000.55m. For coupled neutron-photon problems, specifying a particular isotope on a material card will invoke the neutron set for that isotope and the corresponding photon set for that element. For example, an entry of “1003” on a material card will cause MCNP to use ZAID=1003.50m for neutron data and 1000.01g for photon data.

**TABLE G-3**  
**MGXSNP: A Coupled Neutron-Photon Multigroup Data Library**

<b>ZAID</b>	<b>Neutron AWR</b>	<b>Length</b>	<b>ZAID</b>	<b>Photon AWR</b>	<b>Length</b>
1001.50m	0.999172	3249		1000.01g	0.999317
1002.55m	1.996810	3542			
1003.50m	2.990154	1927			
2003.50m	2.990134	1843		2000.01g	3.968217
2004.50m	3.968238	1629			
3006.50m	5.963479	3566		3000.01g	6.881312
3007.55m	6.955768	3555			
4007.35m	6.949815	1598		4000.01g	8.934763
4009.50m	8.934807	3014			
5010.50m	9.926970	3557		5000.01g	10.717168
5011.56m	10.914679	2795			
6000.50m [1]	11.896972	2933		6000.01g	11.907955
6012.50m [1]	11.896972	2933			
7014.50m	13.882849	3501		7000.01g	13.886438

**APPENDIX G**  
**MULTIGROUP DATA FOR MCNP**

**TABLE G-3 (Cont.)**  
**MGXSNP: A Coupled Neutron-Photon Multigroup Data Library**

<u>ZAID</u>	<u>Neutron AWR</u>	<u>Length</u>	<u>ZAID</u>	<u>Photon AWR</u>	<u>Length</u>
7015.55m	14.871314	2743			
8016.50m	15.857588	3346	8000.01g	15.861942	583
9019.50m	18.835289	3261	9000.01g	18.835197	583
11023.50m	22.792388	2982	11000.01g	22.792275	583
12000.50m	24.096375	3802	12000.01g	24.096261	583
13027.50m	26.749887	3853	13000.01g	26.749756	583
14000.50m	27.844378	3266	14000.01g	27.844241	583
15031.50m	30.707833	2123	15000.01g	30.707682	583
16032.50m	31.697571	2185	16000.01g	31.788823	583
17000.50m	35.148355	2737	17000.01g	35.148180	583
18000.35m	39.605021	2022	18000.01g	39.604489	557
19000.50m	38.762616	2833	19000.01g	38.762423	583
20000.50m	39.734053	3450	20000.01g	39.733857	583
22000.50m	47.455981	3015	22000.01g	47.455747	583
23000.50m	50.504104	2775	23000.01g	50.503856	583
24000.50m	51.549511	3924	24000.01g	51.549253	583
25055.50m	54.466367	2890	25000.01g	54.466099	583
26000.55m	55.366734	4304	26000.01g	55.366466	583
27059.50m	58.427218	2889	27000.01g	58.426930	583
28000.50m	58.182926	3373	28000.01g	58.182641	583
29000.50m	62.999465	2803	29000.01g	62.999157	583
31000.50m	69.124611	2084	31000.01g	69.124270	583
33075.35m	74.278340	2022	33000.01g	74.277979	557
36078.50m	77.251400	2108	36000.01g	83.080137	583
36080.50m	79.230241	2257			
36082.50m	81.210203	2312			
36083.50m	82.202262	2141			
36084.50m	83.191072	2460			
36086.50m	85.173016	2413			
40000.50m	90.440039	2466	40000.01g	90.439594	583
41093.50m	92.108717	2746	41000.01g	92.108263	583
42000.50m	95.107162	1991	42000.01g	95.106691	583
45103.50m	102.021993	2147	45000.01g	102.021490	583
45117.90m	115.544386	2709			
46119.90m	117.525231	2629	46000.01g	105.513949	557
47000.55m	106.941883	2693	47000.01g	106.941685	583
47107.50m	105.987245	2107			
47109.50m	107.969736	1924			
48000.50m	111.442911	1841	48000.01g	111.442363	583
50120.35m	115.995479	1929	50000.01g	117.667336	557
50998.99m	228.025301	1382			
50999.99m	228.025301	1413			
54000.35m	130.171713	1929	54000.01g	130.165202	557
56138.50m	136.721230	2115	56000.01g	136.146809	583

**APPENDIX G**  
**MULTIGROUP DATA FOR MCNP**

**TABLE G-3 (Cont.)**  
**MGXSNP: A Coupled Neutron-Photon Multigroup Data Library**

<b>ZAID</b>	<b>Neutron AWR</b>	<b>Length</b>	<b>ZAID</b>	<b>Photon AWR</b>	<b>Length</b>
63000.35m	150.654333	1933	63000.01g	150.657141	557
63151.55m	149.623005	2976			
63153.55m	151.608005	2691			
64000.35m	155.898915	1929	64000.01g	155.900158	557
67165.55m	163.512997	2526	67000.01g	163.513493	583
73181.50m	179.394458	2787	73000.01g	179.393456	583
74000.55m	182.270446	4360	74000.01g	182.269548	583
74182.55m	180.386082	3687			
74183.55m	181.379499	3628			
74184.55m	182.371615	3664			
74186.55m	184.357838	3672			
75185.50m	183.365036	1968	75000.01g	184.607108	583
75187.50m	185.350629	2061			
78000.35m	193.415026	1929	78000.01g	193.404225	557
79197.56m	195.274027	3490	79000.01g	195.274513	583
82000.50m	205.437162	3384	82000.01g	205.436151	583
83209.50m	207.186158	2524	83000.01g	207.185136	583
90232.50m	230.045857	2896	90000.01g	230.044724	583
91233.50m	231.039442	1970	91000.01g	229.051160	479
92233.50m	231.038833	1988	92000.01g	235.984125	583
92234.50m	232.031554	2150			
92235.50m	233.025921	3164			
92236.50m	234.018959	2166			
92237.50m	235.013509	2174			
92238.50m	236.006966	3553			
92239.35m	236.997601	2147			
93237.55m	235.012957	2812	93000.01g	235.011799	479
94238.50m	236.005745	2442	94000.01g [2]	241.967559	583
94239.55m	236.999740	3038			
94240.50m	237.992791	3044			
94241.50m	238.987218	2856			
94242.50m	239.980508	2956			
95241.50m	238.987196	2535			
95242.50m	239.981303	2284			
95243.50m	240.974535	2480			
96242.50m	239.980599	1970			
96244.50m	241.967311	1950			

note 1. The neutron transport data for ZAID's 6012.50m and 6000.50m are the same.

note 2. Photon transport data are not provided for Z>94.

## APPENDIX G

### DOSIMETRY DATA FOR MCNP

#### V. DOSIMETRY DATA FOR MCNP

The tally multiplier (FM) feature in MCNP allows users to calculate quantities of the form:  $C \int \phi(E) R(E) dE$ , where C is a constant,  $\phi(E)$  is the fluence ( $n/cm^2$ ), and R(E) is a response function. If R(E) is a cross section, and with the appropriate choice of units for C [atom/b·cm], the quantity calculated becomes the total number of some type of reaction per unit volume. If the tally is made over a finite time interval, it becomes a reaction rate per unit volume. In addition to using the standard reaction cross-section information available in our neutron transport libraries, dosimetry or activation reaction data may also be used as a response function. Often only dosimetry data is available for rare nuclides.

A full description of the use of dosimetry data can be found in reference 20. This memorandum also gives a listing of all reaction data that is available for each ZAID. There have been no major revisions of the LLNL/ACTL data since LLLDOS was produced. Users need to remember that dosimetry data libraries are appropriate only when used as a source of R(E) for FM tally multipliers. Dosimetry data libraries can not be used as a source of data for materials through which actual transport is required. TABLE G-4 lists the available dosimetry data libraries for use with MCNP, the evaluation source and date, and the length of the data in words.

**TABLE G-4**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
Z = 1 ***** Hydrogen *****					
1001.30y	1.00782	llldos	LLNL/ACTL	<1983	209
1002.30y	2.01410	llldos	LLNL/ACTL	<1983	149
1003.30y	3.01605	llldos	LLNL/ACTL	<1983	27
Z = 2 ***** Helium *****					
2003.30y	3.01603	llldos	LLNL/ACTL	<1983	267
Z = 3 ***** Lithium *****					
3006.24y	5.96340	531dos	ENDF/B-V	1978	735
3006.26y	5.96340	532dos	ENDF/B-V	1977	713
3006.30y	6.01512	llldos	LLNL/ACTL	<1983	931
3007.26y	6.95570	532dos	ENDF/B-V	1972	733
3007.30y	7.01601	llldos	LLNL/ACTL	<1983	201
Z = 4 ***** Beryllium *****					
4007.30y	7.01693	llldos	LLNL/ACTL	<1983	253
4009.30y	9.01218	llldos	LLNL/ACTL	<1983	335
Z = 5 ***** Boron *****					

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

<b>ZAID</b>	<b>AWR</b>	<b>Library</b>	<b>Source</b>	<b>Date</b>	<b>Length</b>
5010.24y	9.92690	531dos	ENDF/B-V	1979	769
5010.26y	9.92690	532dos	ENDF/B-V	1976	589
5010.30y	10.01290	llldos	LLNL/ACTL	<1983	381
5011.30y	11.00930	llldos	LLNL/ACTL	<1983	119
Z = 6 ***** Carbon *****					
6012.30y	12.00000	llldos	LLNL/ACTL	<1983	97
6013.30y	13.00340	llldos	LLNL/ACTL	<1983	479
6014.30y	14.00320	llldos	LLNL/ACTL	<1983	63
Z = 7 ***** Nitrogen *****					
7014.26y	13.88300	532dos	ENDF/B-V	1973	1013
7014.30y	14.00310	llldos	LLNL/ACTL	<1983	915
Z = 8 ***** Oxygen *****					
8016.26y	15.85800	532dos	ENDF/B-V	1973	95
8016.30y	15.99490	llldos	LLNL/ACTL	<1983	215
8017.30y	16.99910	llldos	LLNL/ACTL	<1983	239
Z = 9 ***** Fluorine *****					
9019.26y	18.83500	532dos	ENDF/B-V	1979	31
9019.30y	18.99840	llldos	LLNL/ACTL	<1983	517
Z = 11 ***** Sodium *****					
11023.30y	22.98980	llldos	LLNL/ACTL	<1983	621
Z = 12 ***** Magnesium *****					
12023.30y	22.99410	llldos	LLNL/ACTL	<1983	333
12024.26y	23.98500	532dos	ENDF/B-V	1979	165
12024.30y	23.98500	llldos	LLNL/ACTL	<1983	309
12025.30y	24.98580	llldos	LLNL/ACTL	<1983	309
12026.30y	25.98260	llldos	LLNL/ACTL	<1983	321
12027.30y	26.98430	llldos	LLNL/ACTL	<1983	309
Z = 13 ***** Aluminum *****					
13026.30y	25.98690	llldos	LLNL/ACTL	<1983	447
13027.24y	26.75000	531dos	ENDF/B-V	1973	1165
13027.26y	26.75000	532dos	ENDF/B-V	1973	1753
13027.30y	26.98150	llldos	LLNL/ACTL	<1983	491

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallyes**

ZAID	AWR	Library	Source	Date	Length
Z = 14 ***** Silicon *****					
14027.30y	26.98670	llldos	LLNL/ACTL	<1983	401
14028.30y	27.97690	llldos	LLNL/ACTL	<1983	377
14029.30y	28.97650	llldos	LLNL/ACTL	<1983	389
14030.30y	29.97380	llldos	LLNL/ACTL	<1983	395
14031.30y	30.97540	llldos	LLNL/ACTL	<1983	337
Z = 15 ***** Phosphorus *****					
15031.26y	30.70800	532dos	ENDF/B-V	1977	65
15031.30y	30.97380	llldos	LLNL/ACTL	<1983	263
Z = 16 ***** Sulfur *****					
16031.30y	30.97960	llldos	LLNL/ACTL	<1983	393
16032.24y	31.69740	531dos	ENDF/B-V	1979	145
16032.26y	31.69700	532dos	ENDF/B-V	1977	35
16032.30y	31.97210	llldos	LLNL/ACTL	<1983	417
16033.30y	32.97150	llldos	LLNL/ACTL	<1983	435
16034.30y	33.96790	llldos	LLNL/ACTL	<1983	437
16035.30y	34.96900	llldos	LLNL/ACTL	<1983	339
16036.30y	35.96710	llldos	LLNL/ACTL	<1983	293
16037.30y	36.97110	llldos	LLNL/ACTL	<1983	279
Z = 17 ***** Chlorine *****					
17034.30y	33.97380	llldos	LLNL/ACTL	<1983	401
17035.30y	34.96890	llldos	LLNL/ACTL	<1983	459
17036.30y	35.96830	llldos	LLNL/ACTL	<1983	563
17037.30y	36.96590	llldos	LLNL/ACTL	<1983	407
7038.30y	37.96800	llldos	LLNL/ACTL	<1983	33
Z = 18 ***** Argon *****					
18036.30y	35.96750	llldos	LLNL/ACTL	<1983	309
18037.30y	36.96680	llldos	LLNL/ACTL	<1983	311
18038.30y	37.96270	llldos	LLNL/ACTL	<1983	311
18039.30y	38.96430	llldos	LLNL/ACTL	<1983	337
18040.26y	39.61910	532dos	ENDF/B-V	1979	3861
18040.30y	39.96240	llldos	LLNL/ACTL	<1983	347
18041.30y	40.96450	llldos	LLNL/ACTL	<1983	317
18042.30y	41.96300	llldos	LLNL/ACTL	<1983	291
18043.30y	42.96570	llldos	LLNL/ACTL	<1983	295
Z = 19 ***** Potassium *****					
19038.30y	37.96910	llldos	LLNL/ACTL	<1983	603
19039.30y	38.96370	llldos	LLNL/ACTL	<1983	405

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
19040.30y	39.96400	l1ldos	LLNL/ACTL	<1983	675
19041.26y	40.60990	532dos	ENDF/B-V	1979	33
19041.30y	40.96180	l1ldos	LLNL/ACTL	<1983	369
19042.30y	41.96240	l1ldos	LLNL/ACTL	<1983	343
19043.30y	42.96070	l1ldos	LLNL/ACTL	<1983	277
19044.30y	43.96160	l1ldos	LLNL/ACTL	<1983	275
19045.30y	44.96070	l1ldos	LLNL/ACTL	<1983	283
19046.30y	45.96200	l1ldos	LLNL/ACTL	<1983	283
<b>Z = 20 ***** Calcium *****</b>					
20039.30y	38.97070	l1ldos	LLNL/ACTL	<1983	601
20040.30y	39.96260	l1ldos	LLNL/ACTL	<1983	309
20041.30y	40.96230	l1ldos	LLNL/ACTL	<1983	313
20042.30y	41.95860	l1ldos	LLNL/ACTL	<1983	285
20043.30y	42.95880	l1ldos	LLNL/ACTL	<1983	295
20044.30y	43.95550	l1ldos	LLNL/ACTL	<1983	269
20045.30y	44.95620	l1ldos	LLNL/ACTL	<1983	271
20046.30y	45.95370	l1ldos	LLNL/ACTL	<1983	255
20047.30y	46.95450	l1ldos	LLNL/ACTL	<1983	243
20048.30y	47.95250	l1ldos	LLNL/ACTL	<1983	239
20049.30y	48.95570	l1ldos	LLNL/ACTL	<1983	229
<b>Z = 21 ***** Scandium *****</b>					
21044.30y	43.95940	l1ldos	LLNL/ACTL	<1983	313
21044.31y	43.95940	l1ldos	LLNL/ACTL	<1983	311
21045.24y	44.56790	531dos	ENDF/B-V	1979	20179
21045.26y	44.56790	532dos	ENDF/B-V	1979	20211
21045.30y	44.95590	l1ldos	LLNL/ACTL	<1983	547
21046.30y	45.95520	l1ldos	LLNL/ACTL	<1983	323
21046.31y	45.95520	l1ldos	LLNL/ACTL	<1983	323
21047.30y	46.95240	l1ldos	LLNL/ACTL	<1983	331
21048.30y	47.95220	l1ldos	LLNL/ACTL	<1983	325
<b>Z = 22 ***** Titanium *****</b>					
22045.30y	44.95810	l1ldos	LLNL/ACTL	<1983	449
22046.24y	45.55780	531dos	ENDF/B-V	1977	53
22046.26y	45.55780	532dos	ENDF/B-V	1977	53
22046.30y	45.95260	l1ldos	LLNL/ACTL	<1983	391
22047.24y	46.54800	531dos	ENDF/B-V	1977	209
22047.26y	46.54800	532dos	ENDF/B-V	1977	209
22047.30y	46.95180	l1ldos	LLNL/ACTL	<1983	419
22048.24y	47.53600	531dos	ENDF/B-V	1977	145
22048.26y	47.53600	532dos	ENDF/B-V	1977	177
22048.30y	47.94790	l1ldos	LLNL/ACTL	<1983	415
22049.30y	48.94790	l1ldos	LLNL/ACTL	<1983	409
22050.26y	49.57000	532dos	ENDF/B-V	1979	33

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
22050.30y	49.94480	llldos	LLNL/ACTL	<1983	345
22051.30y	50.94660	llldos	LLNL/ACTL	<1983	389
<b>Z = 23 ***** Vanadium *****</b>					
23047.30y	46.95490	llldos	LLNL/ACTL	<1983	209
23048.30y	47.95230	llldos	LLNL/ACTL	<1983	399
23049.30y	48.94850	llldos	LLNL/ACTL	<1983	423
23050.30y	49.94720	llldos	LLNL/ACTL	<1983	407
23051.30y	50.94400	llldos	LLNL/ACTL	<1983	357
23052.30y	51.94480	llldos	LLNL/ACTL	<1983	401
<b>Z = 24 ***** Chromium *****</b>					
24049.30y	48.95130	llldos	LLNL/ACTL	<1983	377
24050.26y	49.51650	532dos	ENDF/B-V	1979	7405
24050.30y	49.94600	llldos	LLNL/ACTL	<1983	435
24051.30y	50.94480	llldos	LLNL/ACTL	<1983	377
24052.26y	51.49380	532dos	ENDF/B-V	1979	27
24052.30y	51.94050	llldos	LLNL/ACTL	<1983	417
24053.30y	52.94060	llldos	LLNL/ACTL	<1983	425
24054.30y	53.93890	llldos	LLNL/ACTL	<1983	461
24055.30y	54.94080	llldos	LLNL/ACTL	<1983	419
24056.30y	55.94070	llldos	LLNL/ACTL	<1983	297
<b>Z = 25 ***** Manganese *****</b>					
25051.30y	50.94820	llldos	LLNL/ACTL	<1983	417
25052.30y	51.94560	llldos	LLNL/ACTL	<1983	379
25053.30y	52.94130	llldos	LLNL/ACTL	<1983	425
25054.30y	53.94040	llldos	LLNL/ACTL	<1983	391
25055.24y	54.46610	531dos	ENDF/B-V	1977	119
25055.30y	54.93800	llldos	LLNL/ACTL	<1983	435
25056.30y	55.93890	llldos	LLNL/ACTL	<1983	423
25057.30y	56.93830	llldos	LLNL/ACTL	<1983	419
25058.30y	57.93970	llldos	LLNL/ACTL	<1983	285
<b>Z = 26 ***** Iron *****</b>					
26053.30y	52.94530	llldos	LLNL/ACTL	<1983	387
26054.24y	53.47620	531dos	ENDF/B-V	1979	517
26054.26y	53.47600	532dos	ENDF/B-V	1978	21563
26054.30y	53.93960	llldos	LLNL/ACTL	<1983	457
26055.30y	54.93830	llldos	LLNL/ACTL	<1983	373
26056.24y	55.45400	531dos	ENDF/B-V	1978	449
26056.26y	55.45400	532dos	ENDF/B-V	1978	581
26056.30y	55.93490	llldos	LLNL/ACTL	<1983	415
26057.30y	56.93540	llldos	LLNL/ACTL	<1983	447
26058.24y	57.43560	531dos	ENDF/B-V	1979	7077

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallys**

<b>ZAID</b>	<b>AWR</b>	<b>Library</b>	<b>Source</b>	<b>Date</b>	<b>Length</b>
26058.26y	57.43560	532dos	ENDF/B-V	1979	7097
26058.30y	57.93330	llldos	LLNL/ACTL	<1983	431
26059.30y	58.93490	llldos	LLNL/ACTL	<1983	397
26060.30y	59.93400	llldos	LLNL/ACTL	<1983	285
<b>Z = 27 Cobalt *****</b>					
27057.30y	56.93630	llldos	LLNL/ACTL	<1983	629
27058.30y	57.93580	llldos	LLNL/ACTL	<1983	531
27058.31y	57.93580	llldos	LLNL/ACTL	<1983	569
27059.30y	58.93320	llldos	LLNL/ACTL	<1983	657
27060.30y	59.93380	llldos	LLNL/ACTL	<1983	435
27060.31y	59.93380	llldos	LLNL/ACTL	<1983	499
27061.30y	60.93250	llldos	LLNL/ACTL	<1983	613
27062.30y	61.93400	llldos	LLNL/ACTL	<1983	463
27062.31y	61.93400	llldos	LLNL/ACTL	<1983	519
27063.30y	62.93360	llldos	LLNL/ACTL	<1983	339
27064.30y	63.93580	llldos	LLNL/ACTL	<1983	323
<b>Z = 28 Nickel *****</b>					
28057.30y	56.93980	llldos	LLNL/ACTL	<1983	441
28058.24y	57.43760	531dos	ENDF/B-V	1977	411
28058.26y	57.43760	532dos	ENDF/B-V	1978	4079
28058.30y	57.93530	llldos	LLNL/ACTL	<1983	509
28059.30y	58.93430	llldos	LLNL/ACTL	<1983	513
28060.24y	59.41590	531dos	ENDF/B-V	1977	435
28060.26y	59.41590	532dos	ENDF/B-V	1978	479
28060.30y	59.93080	llldos	LLNL/ACTL	<1983	503
28061.30y	60.93110	llldos	LLNL/ACTL	<1983	489
28062.26y	61.39630	532dos	ENDF/B-V	1978	3847
8062.30y	61.92830	llldos	LLNL/ACTL	<1983	459
28063.30y	62.92970	llldos	LLNL/ACTL	<1983	375
28064.30y	63.92800	llldos	LLNL/ACTL	<1983	397
28065.30y	64.93010	llldos	LLNL/ACTL	<1983	345
<b>Z = 29 Copper *****</b>					
29062.30y	61.93260	llldos	LLNL/ACTL	<1983	507
29063.24y	62.93000	531dos	ENDF/B-V	1978	3375
29063.26y	62.93000	532dos	ENDF/B-V	1978	3615
29063.30y	62.92960	llldos	LLNL/ACTL	<1983	513
29064.30y	63.92980	llldos	LLNL/ACTL	<1983	437
29065.24y	64.92800	531dos	ENDF/B-V	1978	49
29065.26y	64.92800	532dos	ENDF/B-V	1978	49
29065.30y	64.92780	llldos	LLNL/ACTL	<1983	563
29066.30y	65.92890	llldos	LLNL/ACTL	<1983	397
<b>Z = 30 Zinc *****</b>					

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
30064.30y	63.92910	llldos	LLNL/ACTL	<1983	555
30066.30y	65.92600	llldos	LLNL/ACTL	<1983	561
30067.30y	66.92710	llldos	LLNL/ACTL	<1983	411
30068.30y	67.92480	llldos	LLNL/ACTL	<1983	643
30070.30y	69.92530	llldos	LLNL/ACTL	<1983	619
Z = 31 ***** Gallium *****					
31069.30y	68.92560	llldos	LLNL/ACTL	<1983	197
31071.30y	70.92470	llldos	LLNL/ACTL	<1983	419
Z = 32 ***** Germanium *****					
32070.30y	69.92420	llldos	LLNL/ACTL	<1983	405
32072.30y	71.92210	llldos	LLNL/ACTL	<1983	423
32073.30y	72.92350	llldos	LLNL/ACTL	<1983	431
32074.30y	73.92120	llldos	LLNL/ACTL	<1983	629
32076.30y	75.92140	llldos	LLNL/ACTL	<1983	623
Z = 33 ***** Arsenic *****					
33075.30y	74.92160	llldos	LLNL/ACTL	<1983	987
Z = 34 ***** Selenium *****					
34074.30y	73.92250	llldos	LLNL/ACTL	<1983	159
34076.30y	75.91920	llldos	LLNL/ACTL	<1983	177
34080.30y	79.91650	llldos	LLNL/ACTL	<1983	205
34082.30y	81.91670	llldos	LLNL/ACTL	<1983	223
Z = 35 ***** Bromine *****					
35079.30y	78.91830	llldos	LLNL/ACTL	<1983	263
35081.30y	80.91630	llldos	LLNL/ACTL	<1983	695
Z = 37 ***** Rubidium *****					
37085.30y	84.91180	llldos	LLNL/ACTL	<1983	193
37087.30y	86.90920	llldos	LLNL/ACTL	<1983	199
Z = 38 ***** Strontium *****					
38084.30y	83.91340	llldos	LLNL/ACTL	<1983	163
38086.30y	85.90930	llldos	LLNL/ACTL	<1983	33
Z = 39 ***** Yttrium *****					
39089.30y	88.90590	llldos	LLNL/ACTL	<1983	419

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
<b>Z = 40 ***** Zirconium *****</b>					
40089.30y	88.90890	l1ldos	LLNL/ACTL	<1983	321
40090.26y	89.13200	532dos	ENDF/B-V	1976	37
40090.30y	89.90470	l1ldos	LLNL/ACTL	<1983	385
40091.30y	90.90560	l1ldos	LLNL/ACTL	<1983	407
40092.26y	91.11200	532dos	ENDF/B-V	1976	3821
40092.30y	91.90500	l1ldos	LLNL/ACTL	<1983	431
40093.30y	92.90650	l1ldos	LLNL/ACTL	<1983	371
40094.26y	93.09600	532dos	ENDF/B-V	1976	5255
40094.30y	93.90630	l1ldos	LLNL/ACTL	<1983	417
40095.30y	94.90800	l1ldos	LLNL/ACTL	<1983	375
40096.30y	95.90830	l1ldos	LLNL/ACTL	<1983	57
40097.30y	96.91090	l1ldos	LLNL/ACTL	<1983	339
<b>Z = 41 ***** Niobium *****</b>					
41091.30y	90.90700	l1ldos	LLNL/ACTL	<1983	491
41091.31y	90.90700	l1ldos	LLNL/ACTL	<1983	491
41092.30y	91.90720	l1ldos	LLNL/ACTL	<1983	285
41092.31y	91.90720	l1ldos	LLNL/ACTL	<1983	285
41093.30y	92.90640	l1ldos	LLNL/ACTL	<1983	493
41094.30y	93.90730	l1ldos	LLNL/ACTL	<1983	331
41095.30y	94.90680	l1ldos	LLNL/ACTL	<1983	333
41096.30y	95.90810	l1ldos	LLNL/ACTL	<1983	335
41097.30y	96.90810	l1ldos	LLNL/ACTL	<1983	339
41098.30y	97.91030	l1ldos	LLNL/ACTL	<1983	341
41100.30y	99.91420	l1ldos	LLNL/ACTL	<1983	349
<b>Z = 42 ***** Molybdenum *****</b>					
42090.30y	89.91390	l1ldos	LLNL/ACTL	<1983	261
42091.30y	90.91180	l1ldos	LLNL/ACTL	<1983	281
42092.26y	91.21000	532dos	ENDF/B-V	1980	7815
42092.30y	91.90680	l1ldos	LLNL/ACTL	<1983	537
42093.30y	92.90680	l1ldos	LLNL/ACTL	<1983	429
42093.31y	92.90680	l1ldos	LLNL/ACTL	<1983	461
42094.30y	93.90510	l1ldos	LLNL/ACTL	<1983	443
42095.30y	94.90580	l1ldos	LLNL/ACTL	<1983	523
42096.30y	95.90470	l1ldos	LLNL/ACTL	<1983	501
42097.30y	96.90600	l1ldos	LLNL/ACTL	<1983	427
42098.26y	97.06440	532dos	ENDF/B-V	1980	6489
42098.30y	97.90540	l1ldos	LLNL/ACTL	<1983	421
42099.30y	98.90770	l1ldos	LLNL/ACTL	<1983	445
42100.26y	99.04920	532dos	ENDF/B-V	1980	4971
42100.30y	99.90750	l1ldos	LLNL/ACTL	<1983	427
42101.30y	100.91000	l1ldos	LLNL/ACTL	<1983	447

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallyes**

ZAID	AWR	Library	Source	Date	Length
<b>Z = 43 ***** Technetium *****</b>					
43099.30y	98.90620	llldos	LLNL/ACTL	<1983	469
43099.31y	98.90620	llldos	LLNL/ACTL	<1983	469
<b>Z = 45 ***** Rhodium *****</b>					
45103.30y	102.90600	llldos	LLNL/ACTL	<1983	275
<b>Z = 46 ***** Palladium *****</b>					
46110.30y	109.90500	llldos	LLNL/ACTL	<1983	417
<b>Z = 47 ***** Silver *****</b>					
47106.30y	105.90700	llldos	LLNL/ACTL	<1983	263
47106.31y	105.90700	llldos	LLNL/ACTL	<1983	265
47107.30y	106.90500	llldos	LLNL/ACTL	<1983	517
47108.30y	107.90600	llldos	LLNL/ACTL	<1983	275
47108.31y	107.90600	llldos	LLNL/ACTL	<1983	275
47109.30y	108.90500	llldos	LLNL/ACTL	<1983	583
47110.30y	109.90600	llldos	LLNL/ACTL	<1983	277
47110.31y	109.90600	llldos	LLNL/ACTL	<1983	281
<b>Z = 48 ***** Cadmium *****</b>					
48106.30y	105.90600	llldos	LLNL/ACTL	<1983	177
48111.30y	110.90400	llldos	LLNL/ACTL	<1983	317
48112.30y	111.90300	llldos	LLNL/ACTL	<1983	221
48116.30y	115.90500	llldos	LLNL/ACTL	<1983	231
<b>Z = 49 ***** Indium *****</b>					
49113.30y	112.90400	llldos	LLNL/ACTL	<1983	861
49115.24y	113.92000	531dos	ENDF/B-V	1978	26009
49115.26y	113.92000	532dos	ENDF/B-V	1978	26009
49115.30y	114.90400	llldos	LLNL/ACTL	<1983	1265
<b>Z = 50 ***** Tin *****</b>					
50112.30y	111.90500	llldos	LLNL/ACTL	<1983	789
50114.30y	113.90300	llldos	LLNL/ACTL	<1983	435
50115.30y	114.90300	llldos	LLNL/ACTL	<1983	389
50116.30y	115.90200	llldos	LLNL/ACTL	<1983	603
50117.30y	116.90300	llldos	LLNL/ACTL	<1983	313
50118.30y	117.90200	llldos	LLNL/ACTL	<1983	745
50119.30y	118.90300	llldos	LLNL/ACTL	<1983	311
50120.26y	118.87200	532dos	ENDF/B-V	1974	12881
50120.30y	119.90200	llldos	LLNL/ACTL	<1983	309

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

<b>ZAID</b>	<b>AWR</b>	<b>Library</b>	<b>Source</b>	<b>Date</b>	<b>Length</b>
50122.26y	120.85600	532dos	ENDF/B-V	1974	1891
50122.30y	121.90300	llldos	LLNL/ACTL	<1983	275
50124.26y	122.84100	532dos	ENDF/B-V	1974	1693
50124.30y	123.90500	llldos	LLNL/ACTL	<1983	485
Z = 51 *****	Antimony *****				
51121.30y	120.90400	llldos	LLNL/ACTL	<1983	811
51123.30y	122.90400	llldos	LLNL/ACTL	<1983	1013
Z = 53 *****	Iodine *****				
53127.24y	125.81400	531dos	ENDF/B-V	1972	115
53127.26y	125.81400	532dos	ENDF/B-V	1980	14145
53127.30y	126.90400	llldos	LLNL/ACTL	<1983	221
Z = 55 *****	Cesium *****				
55133.30y	132.90500	llldos	LLNL/ACTL	<1983	215
Z = 57 *****	Lanthanum *****				
57139.26y	137.71300	532dos	ENDF/B-V	1980	15475
Z = 58 *****	Cerium *****				
58140.30y	139.90500	llldos	LLNL/ACTL	<1983	427
58142.30y	141.90900	llldos	LLNL/ACTL	<1983	265
Z = 59 *****	Praseodymium *****				
59141.30y	140.90800	llldos	LLNL/ACTL	<1983	215
Z = 60 *****	Neodymium *****				
60142.30y	141.90800	llldos	LLNL/ACTL	<1983	207
60148.30y	147.91700	llldos	LLNL/ACTL	<1983	255
60150.30y	149.92100	llldos	LLNL/ACTL	<1983	259
Z = 62 *****	Samarium *****				
62144.30y	143.91200	llldos	LLNL/ACTL	<1983	189
62148.30y	147.91500	llldos	LLNL/ACTL	<1983	245
62152.30y	151.92000	llldos	LLNL/ACTL	<1983	237
62154.30y	153.92200	llldos	LLNL/ACTL	<1983	247
Z = 63 *****	Europium *****				
63151.30y	150.92000	llldos	LLNL/ACTL	<1983	731

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
63153.30y	152.92100	llldos	LLNL/ACTL	<1983	565
<b>Z = 64 ***** Gadolinium *****</b>					
64150.30y	149.91900	llldos	LLNL/ACTL	<1983	237
64151.30y	150.92000	llldos	LLNL/ACTL	<1983	241
<b>Z = 66 ***** Dysprosium *****</b>					
66164.26y	162.52000	532dos	ENDF/B-V	1967	581
<b>Z = 67 ***** Holmium *****</b>					
67163.30y	162.92900	llldos	LLNL/ACTL	<1983	533
67164.30y	163.93000	llldos	LLNL/ACTL	<1983	327
67164.31y	163.93000	llldos	LLNL/ACTL	<1983	327
67165.30y	164.93000	llldos	LLNL/ACTL	<1983	589
67166.30y	165.93200	llldos	LLNL/ACTL	<1983	333
67166.31y	165.93200	llldos	LLNL/ACTL	<1983	333
<b>Z = 69 ***** Thulium *****</b>					
69169.30y	168.93400	llldos	LLNL/ACTL	<1983	453
<b>Z = 71 ***** Lutetium *****</b>					
71173.30y	172.93900	llldos	LLNL/ACTL	<1983	587
71174.30y	173.94000	llldos	LLNL/ACTL	<1983	417
71174.31y	173.94000	llldos	LLNL/ACTL	<1983	465
71175.30y	174.94100	llldos	LLNL/ACTL	<1983	559
71176.30y	175.94300	llldos	LLNL/ACTL	<1983	621
71176.31y	175.94300	llldos	LLNL/ACTL	<1983	637
71177.30y	176.94400	llldos	LLNL/ACTL	<1983	573
71177.31y	176.94400	llldos	LLNL/ACTL	<1983	573
<b>Z = 72 ***** Hafnium *****</b>					
72174.30y	173.94000	llldos	LLNL/ACTL	<1983	147
72175.30y	174.94100	llldos	LLNL/ACTL	<1983	121
72176.30y	175.94100	llldos	LLNL/ACTL	<1983	153
72177.30y	176.94300	llldos	LLNL/ACTL	<1983	157
72178.30y	177.94400	llldos	LLNL/ACTL	<1983	153
72179.30y	178.94600	llldos	LLNL/ACTL	<1983	433
72180.30y	179.94700	llldos	LLNL/ACTL	<1983	409
72181.30y	180.94900	llldos	LLNL/ACTL	<1983	365
72183.30y	182.95400	llldos	LLNL/ACTL	<1983	373
<b>Z = 73 ***** Tantalum *****</b>					

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

<b>ZAID</b>	<b>AWR</b>	<b>Library</b>	<b>Source</b>	<b>Date</b>	<b>Length</b>
73179.30y	178.94600	llldos	LLNL/ACTL	<1983	629
73180.30y	179.94700	llldos	LLNL/ACTL	<1983	523
73180.31y	179.94700	llldos	LLNL/ACTL	<1983	435
73181.30y	180.94800	llldos	LLNL/ACTL	<1983	715
73182.30y	181.95000	llldos	LLNL/ACTL	<1983	435
73182.31y	181.95000	llldos	LLNL/ACTL	<1983	447
73183.30y	182.95100	llldos	LLNL/ACTL	<1983	425
73184.30y	183.95400	llldos	LLNL/ACTL	<1983	371
73186.30y	185.95900	llldos	LLNL/ACTL	<1983	377
<b>Z = 74 ***** Tungsten *****</b>					
74179.30y	178.94700	llldos	LLNL/ACTL	<1983	263
74180.30y	179.94700	llldos	LLNL/ACTL	<1983	397
74181.30y	180.94800	llldos	LLNL/ACTL	<1983	263
74182.30y	181.94800	llldos	LLNL/ACTL	<1983	415
74183.30y	182.95000	llldos	LLNL/ACTL	<1983	499
74184.30y	183.95100	llldos	LLNL/ACTL	<1983	443
74185.30y	184.95300	llldos	LLNL/ACTL	<1983	267
74186.30y	185.95400	llldos	LLNL/ACTL	<1983	413
74187.30y	186.95700	llldos	LLNL/ACTL	<1983	279
74188.30y	187.95800	llldos	LLNL/ACTL	<1983	271
<b>Z = 75 ***** Rhenium *****</b>					
75184.30y	183.95300	llldos	LLNL/ACTL	<1983	331
75184.31y	183.95300	llldos	LLNL/ACTL	<1983	335
75185.30y	184.95300	llldos	LLNL/ACTL	<1983	373
75186.30y	185.95500	llldos	LLNL/ACTL	<1983	381
75187.30y	186.95600	llldos	LLNL/ACTL	<1983	547
75188.30y	187.95800	llldos	LLNL/ACTL	<1983	339
75188.31y	187.95800	llldos	LLNL/ACTL	<1983	341
<b>Z = 77 ***** Iridium *****</b>					
77191.30y	190.96100	llldos	LLNL/ACTL	<1983	237
77193.30y	192.96300	llldos	LLNL/ACTL	<1983	243
77194.30y	193.96500	llldos	LLNL/ACTL	<1983	421
<b>Z = 78 ***** Platinum *****</b>					
78190.30y	189.96000	llldos	LLNL/ACTL	<1983	151
78192.30y	191.96100	llldos	LLNL/ACTL	<1983	153
78193.30y	192.96300	llldos	LLNL/ACTL	<1983	123
78193.31y	192.96300	llldos	LLNL/ACTL	<1983	123
78194.30y	193.96300	llldos	LLNL/ACTL	<1983	211
78195.30y	194.96500	llldos	LLNL/ACTL	<1983	157
78196.30y	195.96500	llldos	LLNL/ACTL	<1983	157
78197.30y	196.96700	llldos	LLNL/ACTL	<1983	427

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
78197.31y	196.96700	llldos	LLNL/ACTL	<1983	129
78198.30y	197.96800	llldos	LLNL/ACTL	<1983	183
78199.30y	198.97100	llldos	LLNL/ACTL	<1983	99
78199.31y	198.97100	llldos	LLNL/ACTL	<1983	99
Z = 79 ***** Gold *****					
79193.30y	192.96400	llldos	LLNL/ACTL	<1983	209
79194.30y	193.96500	llldos	LLNL/ACTL	<1983	261
79195.30y	194.96500	llldos	LLNL/ACTL	<1983	261
79196.30y	195.96700	llldos	LLNL/ACTL	<1983	265
79196.31y	195.96700	llldos	LLNL/ACTL	<1983	265
79197.30y	196.96700	llldos	LLNL/ACTL	<1983	307
79198.30y	197.96800	llldos	LLNL/ACTL	<1983	265
79199.30y	198.96900	llldos	LLNL/ACTL	<1983	269
79200.30y	199.97100	llldos	LLNL/ACTL	<1983	39
Z = 80 ***** Mercury *****					
80202.30y	201.97100	llldos	LLNL/ACTL	<1983	381
80203.30y	202.97300	llldos	LLNL/ACTL	<1983	379
80204.30y	203.97300	llldos	LLNL/ACTL	<1983	365
Z = 81 ***** Thallium *****					
81202.30y	201.97200	llldos	LLNL/ACTL	<1983	377
81203.30y	202.97200	llldos	LLNL/ACTL	<1983	375
81204.30y	203.97400	llldos	LLNL/ACTL	<1983	373
81205.30y	204.97400	llldos	LLNL/ACTL	<1983	369
Z = 82 ***** Lead *****					
82203.30y	202.97300	llldos	LLNL/ACTL	<1983	257
82204.30y	203.97300	llldos	LLNL/ACTL	<1983	405
82205.30y	204.97400	llldos	LLNL/ACTL	<1983	257
82206.30y	205.97400	llldos	LLNL/ACTL	<1983	347
82207.30y	206.97600	llldos	LLNL/ACTL	<1983	333
82208.30y	207.97700	llldos	LLNL/ACTL	<1983	263
82209.30y	208.98100	llldos	LLNL/ACTL	<1983	279
82210.30y	209.98400	llldos	LLNL/ACTL	<1983	351
Z = 83 ***** Bismuth *****					
83208.30y	207.98000	llldos	LLNL/ACTL	<1983	409
83209.30y	208.98000	llldos	LLNL/ACTL	<1983	551
83210.30y	209.98400	llldos	LLNL/ACTL	<1983	421
83210.31y	209.98400	llldos	LLNL/ACTL	<1983	421

**APPENDIX G**  
**DOSIMETRY DATA FOR MCNP**

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
Z = 84 ***** Polonium *****					
84210.30y	209.98300	llldos	LLNL/ACTL	<1983	441
Z = 90 ***** Thorium *****					
90230.30y	230.03300	llldos	LLNL/ACTL	<1983	209
90231.30y	231.03600	llldos	LLNL/ACTL	<1983	599
90232.30y	232.03800	llldos	LLNL/ACTL	<1983	347
90233.30y	233.04200	llldos	LLNL/ACTL	<1983	561
90234.30y	234.04400	llldos	LLNL/ACTL	<1983	37
Z = 91 ***** Protactinium *****					
91231.26y	229.05000	532dos	ENDF/B-V	1978	2861
91233.26y	231.03800	532dos	ENDF/B-V	1978	73
91233.30y	233.04000	llldos	LLNL/ACTL	<1983	361
Z = 92 ***** Uranium *****					
92233.26y	231.04300	532dos	ENDF/B-V	1978	75
92233.30y	233.04000	llldos	LLNL/ACTL	<1983	461
92234.30y	234.04100	llldos	LLNL/ACTL	<1983	393
92235.30y	235.04400	llldos	LLNL/ACTL	<1983	4629
92236.30y	236.04600	llldos	LLNL/ACTL	<1983	395
92237.30y	237.04900	llldos	LLNL/ACTL	<1983	609
92238.30y	238.05100	llldos	LLNL/ACTL	<1983	3103
92239.30y	239.05400	llldos	LLNL/ACTL	<1983	825
92240.30y	240.05700	llldos	LLNL/ACTL	<1983	389
Z = 93 ***** Neptunium *****					
93237.30y	237.04800	llldos	LLNL/ACTL	<1983	629
Z = 94 ***** Plutonium *****					
94237.30y	237.04800	llldos	LLNL/ACTL	<1983	487
94238.30y	238.05000	llldos	LLNL/ACTL	<1983	459
94239.30y	239.05200	llldos	LLNL/ACTL	<1983	497
94240.30y	240.05400	llldos	LLNL/ACTL	<1983	479
94241.30y	241.05700	llldos	LLNL/ACTL	<1983	559
94242.30y	242.05900	llldos	LLNL/ACTL	<1983	505
94243.30y	243.06200	llldos	LLNL/ACTL	<1983	511
Z = 95 ***** Americium *****					
95241.30y	241.05700	llldos	LLNL/ACTL	<1983	673
95242.30y	242.06000	llldos	LLNL/ACTL	<1983	473
95243.30y	243.06100	llldos	LLNL/ACTL	<1983	431

## APPENDIX G REFERENCES

**TABLE G-4 (Cont.)**  
**Dosimetry Data Libraries for MCNP Tallies**

ZAID	AWR	Library	Source	Date	Length
<b>Z = 96 ***** Curium *****</b>					
96242.30y	242.05900	llldos	LLNL/ACTL	<1983	467
96243.30y	243.06100	llldos	LLNL/ACTL	<1983	465
96244.30y	244.06300	llldos	LLNL/ACTL	<1983	483
96245.30y	245.06500	llldos	LLNL/ACTL	<1983	465
96246.30y	246.06700	llldos	LLNL/ACTL	<1983	491
96247.30y	247.07000	llldos	LLNL/ACTL	<1983	491
96248.30y	248.07200	llldos	LLNL/ACTL	<1983	495
<b>Z = 97 ***** Berkelium *****</b>					
97249.30y	249.07500	llldos	LLNL/ACTL	<1983	545
<b>Z = 98 ***** Californium *****</b>					
98249.30y	249.07500	llldos	LLNL/ACTL	<1983	491
98250.30y	250.07600	llldos	LLNL/ACTL	<1983	335
98251.30y	251.08000	llldos	LLNL/ACTL	<1983	485
98252.30y	252.08200	llldos	LLNL/ACTL	<1983	467

## VI. REFERENCES

1. V. McLane, C. L. Dunford, and P.F. Rose, ed., "ENDF-102: Data Formats and Procedures for the Evaluated Nuclear Data File ENDF-6," BNL report, BNL-NCS-44945, revised (1995).
2. R. C. Little, "New Photon Library from ENDF Data," LANL internal memorandum to Buck Thompson (February 26, 1982).
3. H. G. Hughes, "Information on the Photon Library MCPLIB02," LANL internal memorandum X-6:HGH-93-77 (revised 1996).
4. R. C. Little, "Summary Documentation for the 100XS Neutron Cross Section Library (Release 1)," LANL internal memorandum XTM:RCL-95-259 and LA-UR-96-24 (1995).
5. R. C. Little, "Argon and Krypton Cross-section Files," LANL internal memorandum (June 30, 1982).
6. R. C. Little, "Cross Sections in ACE Format for Various IP Target Materials," LANL internal memorandum (August 19, 1982).

## APPENDIX G REFERENCES

7. R. C. Little, "Y-89 cross sections for MCNP," LANL internal memorandum X-6:RCL-85-419, (1985).
8. R. C. Little, "Modified ENDF/B-V.0 Y-89 cross sections for MCNP," LANL internal memorandum X-6:RCL-85-443, (1985).
9. R. E. Seamon, "Revised ENDF/B-V Zirconium Cross Sections," LANL internal memorandum X-6:RES-92-324 (1992).
10. S. C. Frankle, "ENDL Fission Products, ENDL85 and ENDL92," LANL internal memorandum XTM:95-254, (1995).
11. S. C. Frankle, "Summary Documentation for the ENDL92 Continuous-Energy Neutron Data Library (Release 1)," LANL Unclassified Release, XTM:96-05 and LA-UR-96-327, (1996).
12. R. Little and R. Seamon, "ENDF/B-V.0 Gd Cross Sections with Photon Production," LANL internal memorandum X-6:RCL-87-132, (1986).
13. S. C. Frankle, "ENDF62MT: A Multitemperature Neutron Library for MCNP (Rev. 0)," LANL internal memorandum XTM:SCF-96-153 (1996).
14. R. C. Little, "Neutron and Photon Multigroup Data Tables for MCNP3B," LANL internal memorandum X-6:RCL-87-225 (1987).
15. R. C. Little and R. E. Seamon, "New MENDF5 and MENDF5G," LANL internal memorandum X-6:RCL-86-412 (1986).
16. J. C. Wagner et al., "MCNP: Multigroup/Adjoint Capabilities," LANL report LA-12704 (1994).
17. R. E. Seamon, "Weight Functions for the Isotopes on Permfile THIRTY2," LANL Internal memorandum TD-6 (July 23, 1976).
18. R. E. Seamon, "Plots of the TD Weight Function," LANL internal memorandum, X-6:RES-91-80 (1980).
19. R. E. MacFarlane and D. W. Muir, "The NJOY Nuclear Data Processing System," LANL report LA-12740 (1994).
20. R. C. Little and R. E. Seamon, "Dosimetry/Activation Cross Sections for MCNP," LANL internal memorandum, March 13, 1984.

## **APPENDIX G**

### **REFERENCES**

## APPENDIX H CONSTANTS FOR FISSION SPECTRA

### APPENDIX H

#### FISSION SPECTRA CONSTANTS AND FLUX-TO-DOSE FACTORS

This Appendix is divided into two sections: fission spectra constants to be used with the SP input card and ANSI standard flux-to-dose conversion factors to be used with the DE and DF input cards.

##### **I. CONSTANTS FOR FISSION SPECTRA**

The following is a list of recommended parameters for use with the MCNP source fission spectra and the SP input card described in Chapter 3. The constants for neutron-induced fission are taken directly from the ENDF/B-V library. For each fissionable isotope, constants are given for either the Maxwell spectrum or the Watt spectrum, but not both. The Watt fission spectrum is preferred to the Maxwell fission spectrum. The constants for spontaneously fissioning isotopes are supplied by Madland of Group T-2. If you desire constants for isotopes other than those listed below, contact X-5. Note that both the Watt and Maxwell fission spectra are approximations. A more accurate representation has been developed by Madland in T-2. If you are interested in this spectrum, contact X-5.

###### **A. Constants for the Maxwell fission spectrum (neutron-induced)**

$$f(E) = CE^{1/2} \exp(-E/a)$$

	Incident Neutron Energy (MeV)	a(MeV)
n + <sup>233</sup> Pa	Thermal	1.3294
	1	1.3294
	14	1.3294
n + <sup>234</sup> U	Thermal	1.2955
	1	1.3086
	14	1.4792
n + <sup>236</sup> U	Thermal	1.2955
	1	1.3086
	14	1.4792
n + <sup>237</sup> U	Thermal	1.2996
	1	1.3162
	14	1.5063
n + <sup>237</sup> Np	Thermal	1.315
	1	1.315
	14	1.315

**APPENDIX H**  
**CONSTANTS FOR FISSION SPECTRA**

	<b>Incident Neutron Energy (MeV)</b>	<b>a(MeV)</b>
$n + {}^{238}\text{Pu}$	Thermal	1.330
	1	1.330
	14	1.330
$n + {}^{240}\text{Pu}$	Thermal	1.346
	1	1.3615
	14	1.547
$n + {}^{241}\text{Pu}$	Thermal	1.3597
	1	1.3752
	14	1.5323
$n + {}^{242}\text{Pu}$	Thermal	1.337
	1	1.354
	14	1.552
$n + {}^{241}\text{Am}$	Thermal	1.330
	1	1.330
	14	1.330
$n + {}^{242m}\text{Pu}$	Thermal	1.330
	1	1.330
	14	1.330
$n + {}^{243}\text{Am}$	Thermal	1.330
	1	1.330
	14	1.330
$n + {}^{242}\text{Cm}$	Thermal	1.330
	1	1.330
	14	1.330
$n + {}^{244}\text{Cm}$	Thermal	1.330
	1	1.330
	14	1.330
$n + {}^{245}\text{Cm}$	Thermal	1.4501
	1	1.4687
	14	1.6844
$n + {}^{246}\text{Cm}$	Thermal	1.3624
	1	1.4075
	14	1.6412

## APPENDIX H

### FLUX-TO-DOSE CONVERSION FACTORS

#### B. Constants for the Watt Fission Spectrum

$$f(E) = C \exp(-E/a) \sinh(bE)^{1/2}$$

##### 1. Neutron-Induced Fission

	Incident Neutron Energy (MeV)	a(MeV)	b(MeV <sup>-1</sup> )
n + <sup>232</sup> Th	Thermal	1.0888	1.6871
	1	1.1096	1.6316
	14	1.1700	1.4610
n + <sup>233</sup> U	Thermal	0.977	2.546
	1	0.977	2.546
	14	1.0036	2.6377
n + <sup>235</sup> U	Thermal	0.988	2.249
	1	0.988	2.249
	14	1.028	2.084
n + <sup>238</sup> U	Thermal	0.88111	3.4005
	1	0.89506	3.2953
	14	0.96534	2.8330
n + <sup>239</sup> Pu	Thermal	0.966	2.842
	1	0.966	2.842
	14	1.055	2.383

##### 2. Spontaneous Fission

	a(MeV)	b(MeV <sup>-1</sup> )
<sup>240</sup> Pu	0.799	4.903
<sup>242</sup> Pu	0.833668	4.431658
<sup>242</sup> Cm	0.891	4.046
<sup>244</sup> Cm	0.906	3.848
<sup>252</sup> Cf	1.025	2.926

## II. FLUX-TO-DOSE CONVERSION FACTORS

This section presents several flux-to-dose rate conversion factor sets for use on the DE and DF tally cards to convert from calculated particle flux to human biological dose equivalent rate. These sets of conversion factors are not the only ones in existence, nor are they recommended by this

## **APPENDIX H**

### **FLUX-TO-DOSE CONVERSION FACTORS**

publication. Rather, they are presented for convenience should you decide that one is appropriate for your use. The original publication cited or other sources should be consulted to determine if they are appropriate for your application.

Although the various conversion factor sets differ from one another, it seems to be the consensus of the health physics community that they do not differ significantly from most health physics applications where accuracies of 20% are generally acceptable. Some of the differences in the various sets are attributable to different assumptions about source directionality, phantom geometry, and depth of penetration. The neutron quality factors, derived primarily from animal experiments, are also somewhat different.

Be aware that conversion factor sets are subject to change based on the actions of various national and international organizations such as the National Council on Radiation Protection and Measurements (NCRP), the International Commission on Radiological Protection (ICRP), the International Commission on Radiation Units and Measurements (ICRU), the American National Standards Institute (ANSI), and the American Nuclear Society (ANS). Changes may be based on the re-evaluation of existing data and calculations or on the availability of new information. Currently, a revision of the 1977 ANSI/ANS<sup>1</sup> conversion factors is under way and the ICRP and NCRP are considering an increase in the neutron quality factors by a factor of 2 to 2.5.

In addition to biological dose factors, a reference is given for silicon displacement kerma factors for potential use in radiation effects assessment of electronic semiconductor devices. The use of these factors is subject to the same caveats stated above for biological dose rates.

#### **A. *Biological Dose Equivalent Rate Factors***

In the following discussions, dose rate will be used interchangeably with biological dose equivalent rate. In all cases the conversion factors will contain the quality factors used to convert the absorbed dose in rads to rem. The neutron quality factors implicit in the conversion factors are also tabulated for information. For consistency, all conversion factors are given in units of rem/h per unit flux (particles/cm<sup>2</sup>-s) rather than in the units given by the original publication. The interpolation mode chosen should correspond to that recommended by the reference. For example, the ANSI/ANS publication recommends log-log interpolation; significant differences at interpolated energies can result if a different interpolation scheme is used.

##### **1. Neutrons**

The NCRP-38 (Ref. 2) and ICRP-21 (Ref. 3) neutron flux-to-dose rate conversion factors and quality factors are listed in Table H.1. Note that the 1977 ANSI/ANS factors referred to earlier were taken from NCRP-38 and therefore are not listed separately.

##### **2. Photons**

## APPENDIX H

### FLUX-TO-DOSE CONVERSION FACTORS

The 1977 ANSI/ANS<sup>1</sup> and the ICRP-21 (Ref. 3) photon flux-to-dose rate conversion factors are given in Table H.2. No tabulated set of photon conversion factors have been provided by the NCRP as far as can be determined. Note that the 1977 ANSI/ANS and the ICRP-21 conversion factor sets differ significantly (>20%) below approximately 0.7 MeV with maximum disagreement occurring at ~0.06 MeV, where the ANSI/ANS value is about 2.3 times larger than the ICRP value.

#### **B. Silicon Displacement Kerma Factors**

Radiation damage to or effects on electronic components are often of interest in radiation fields. Of particular interest are the absorbed dose in rads and silicon displacement kerma factors. The absorbed dose may be calculated for a specific material by using the FM tally card discussed in Chapter 3 with an appropriate constant C to convert from the MCNP default units to rads. The silicon displacement kermas, however, are given as a function of energy, similar to the biological conversion factors. Therefore, they may be implemented on the DE and DF cards. One source of these kerma factors and a discussion of their significance and use can be found in Reference 4.

**TABLE H-1:**  
**Neutron Flux-to-Dose Rate Conversion Factors and Quality Factors**  
**NCRP-38, ANSI/ANS-6.1.1-1977\***      **ICRP-21**

<b>Energy, E (MeV)</b>	<b>DF(E) (rem/hr)/(n/cm<sup>2</sup>-s)</b>	<b>Quality Factor</b>	<b>DF(E) (rem/hr)/(n/cm<sup>2</sup>-s)</b>	<b>Quality Factor</b>
2.5E-08	3.67E-06	2.0	3.85E-06	2.3
1.0E-07	3.67E-06	2.0	4.17E-06	2.0
1.0E-06	4.46E-06	2.0	4.55E-06	2.0
1.0E-05	4.54E-06	2.0	4.35E-06	2.0
1.0E-04	4.18E-06	2.0	4.17E-06	2.0
1.0E-03	3.76E-06	2.0	3.70E-06	2.0
1.0E-02	3.56E-06	2.5	3.57E-06	2.0
1.0E-01	2.17E-05	7.5	2.08E-05	7.4
5.0E-01	9.26E-05	11.0	7.14E-05	11.0
1.0	1.32E-04	11.0	1.18E-04	10.6
2.0			1.43E-04	9.3
2.5	1.25E-04	9.0		
5.0	1.56E-04	8.0	1.47E-04	7.8
7.0	1.47E-04	7.0		
10.0	1.47E-04	6.5	1.47E-04	6.8
14.0	2.08E-04	7.5		
20.0	2.27E-04	8.0	1.54E-04	6.0

\*Extracted from American National Standard ANSI/ANS-6.1.1-1977 with permission of the publisher, the American Nuclear Society.

**APPENDIX H**  
**FLUX-TO-DOSE CONVERSION FACTORS**

<b>TABLE H-2:</b>			
<b>Photon Flux-to-Dose Rate Conversion Factors</b>			
<b>ANSI/ANS-6.1.1-1977</b>		<b>ICRP-21</b>	
<b>Energy, E</b> <b>(MeV)</b>	<b>DF(E)</b> <b>(rem/hr)/(p/cm<sup>2</sup>-s)</b>	<b>Energy, E</b> <b>(MeV)</b>	<b>DF(E)</b> <b>(rem/hr)/(p/cm<sup>2</sup>-s)</b>
0.01	3.96E-06	0.01	2.78E-06
0.03	5.82E-07	0.015	1.11E-06
0.05	2.90E-07	0.02	5.88E-07
0.07	2.58E-07	0.03	2.56E-07
0.1	2.83E-07	0.04	1.56E-07
0.15	3.79E-07	0.05	1.20E-07
0.2	5.01E-07	0.06	1.11E-07
0.25	6.31E-07	0.08	1.20E-07
0.3	7.59E-07	0.1	1.47E-07
0.35	8.78E-07	0.15	2.38E-07
0.4	9.85E-07	0.2	3.45E-07
0.45	1.08E-06	0.3	5.56E-07
0.5	1.17E-06	0.4	7.69E-07
0.55	1.27E-06	0.5	9.09E-07
0.6	1.36E-06	0.6	1.14E-06
0.65	1.44E-06	0.8	1.47E-06
0.7	1.52E-06	1.	1.79E-06
0.8	1.68E-06	1.5	2.44E-06
1.0	1.98E-06	2.	3.03E-06
1.4	2.51E-06	3.	4.00E-06
1.8	2.99E-06	4.	4.76E-06
2.2	3.42E-06	5.	5.56E-06
2.6	3.82E-06	6.	6.25E-06
2.8	4.01E-06	8.	7.69E-06
3.25	4.41E-06	10.	9.09E-06
3.75	4.83E-06		
4.25	5.23E-06		
4.75	5.60E-06		
5.0	5.80E-06		
5.25	6.01E-06		
5.75	6.37E-06		
6.25	6.74E-06		
6.75	7.11E-06		

**TABLE H-2: (Cont.)  
Photon Flux-to-Dose Rate Conversion Factors**

ANSI/ANS-6.1.1-1977	ICRP-21
Energy, E (MeV)	DF(E) (rem/hr)/(p/cm <sup>2</sup> -s)
7.5	7.66E-06
9.0	8.77E-06
11.0	1.03E-05
13.0	1.18E-05
15.0	1.33E-05

Energy, E (MeV)	DF(E) (rem/hr)/(p/cm <sup>2</sup> -s)	Energy, E (MeV)	DF(E) (rem/hr)/(p/cm <sup>2</sup> -s)
7.5	7.66E-06		
9.0	8.77E-06		
11.0	1.03E-05		
13.0	1.18E-05		
15.0	1.33E-05		

### **III. REFERENCES**

1. ANS-6.1.1 Working Group, M. E. Battat (Chairman), "American National Standard Neutron and Gamma-Ray Flux-to-Dose Rate Factors," ANSI/ANS-6.1.1-1977 (N666), American Nuclear Society, LaGrange Park, Illinois (1977).
2. NCRP Scientific Committee 4 on Heavy Particles, H. H. Rossi, chairman, "Protection Against Neutron Radiation," NCRP-38, National Council on Radiation Protection and Measurements (January 1971).
3. ICRP Committee 3 Task Group, P. Grande and M. C. O'Riordan, chairmen, "Data for Protection Against Ionizing Radiation from External Sources: Supplement to ICRP Publication 15," ICRP-21, International Commission on Radiological Protection, Pergamon Press (April 1971).
4. ASTM Committee E-10 on Nuclear Technology and Applications, "Characterizing Neutron Energy Fluence Spectra in Terms of an Equivalent Monoenergetic Neutron Fluence for Radiation-Hardness Testing of Electronics," American Society for Testing and Materials Standard E722-80, Annual Book of ASTM Standards (1980).

CHAPTER 2  
INP File

**APPENDIX I****PTRAC TABLES**

TABLE I-1 presents the format of the PTRAC output file. TABLE I-2 –TABLE I-7 provide a detailed description of each variable in the output file. Note that capitalized variables with three or more characters refer to MCNP FORTRAN variables (except where noted) and are defined in Appendix E.

**TABLE I-1**  
**Format of the PTRAC Output File**

<b>Format</b>	<b>ASCII</b>		<b>Binary</b>
	<b>Line</b>	<b>Format</b>	<b>Record</b>
-1	1	(i5)	1
KOD, VER, LODDAT, IDTM	2	(a8,a5,a8,a19)	2
AID	3	(a80)	3
$m n_1 V_1^1 V_2^1 \dots V_{n_1}^1 \dots$	4	(1x,10e12.4)	4
. K total lines of PTRAC input data (see TABLE I-2 )			
$N_1 N_2 \dots N_{20}$	4+K	(1x,20i5)	4+K
$L_1 L_2 \dots L_{N1}$	5+K	(1x,30i4)	5+K
$L_1^1 L_2^1 \dots L_{N2+N3}^1$			
. M total lines of variable IDs			
***** End of Header – Start NPS and Event Lines *****			
$I_1^1 I_2^1 \dots I_{N1}^1$	5+K+M	(1x,5i10,e13.5)	6+K
$J_1^1 J_2^1 \dots J_{N2,4,6,8,10}^1$	6+K+M	(1x,8i10)	7+K
$P_1^1 P_2^1 \dots P_{N3,5,7,9,11}^1$	7+K+M	(1x,9e13.5)	
$J_1^2 J_2^2 \dots J_{N2,4,6,8,10}^2$	8+K+M	(1x,8i10)	8+K
$P_1^2 P_2^2 \dots P_{N3,5,7,9,11}^2$	9+K+M	(1x,9e13.5)	
. Q total lines of event data for this history (see TABLE I-3 )			
$I_1^2 I_2^2 \dots I_{N1}^2$	5+K+M+Q	(1x,5i10,e13.5)	6+K+Q/2
.			

## APPENDIX I

**TABLE I-1**  
**Format of the PTRAC Output File**

See TABLE I-3 for all possible values of  $N_2 - N_{11}$

$N_1$  = Number of variables on the NPS line ( $I_1 I_2 \dots$ ).

$N_2$  = Number of variables on 1<sup>st</sup> event line for an “src” event.  
 $N_3$  = Number of variables on 2<sup>nd</sup> event line for an “src” event.  
 $N_4$  = Number of variables on 1<sup>st</sup> event line for a “bnk” event.  
 $N_5$  = Number of variables on 2<sup>nd</sup> event line for a “bnk” event.  
 $N_6$  = Number of variables on 1<sup>st</sup> event line for a “sur” event.  
 $N_7$  = Number of variables on 2<sup>nd</sup> event line for a “sur” event.  
 $N_8$  = Number of variables on 1<sup>st</sup> event line for a “col” event.  
 $N_9$  = Number of variables on 2<sup>nd</sup> event line for a “col” event.  
 $N_{10}$  = Number of variables on 1<sup>st</sup> event line for a “ter” event.  
 $N_{11}$  = Number of variables on 2<sup>nd</sup> event line for a “ter” event.

$N_{12}$  = IPT for single particle transport, otherwise 0.

$N_{13} = 4$  for real\*4 output and 8 for real\*8 output

$N_{14} - N_{20}$  = not used.

See TABLE I-4 for definitions of variable IDs:

$L_1 L_2 \dots L_{N1}$	= List of variable IDs for the NPS line.
$L_1 L_2^1 \dots L_{N2+N3}^1$	= List of variable IDs for an “src” event.
$L_1^2 L_2^2 \dots L_{N4+N5}^2$	= List of variable IDs for a “bnk” event.
$L_1^3 L_2^3 \dots L_{N6+N7}^3$	= List of variable IDs for a “sur” event.
$L_1^4 L_2^4 \dots L_{N8+N9}^4$	= List of variable IDs for a “col” event.
$L_1^5 L_2^5 \dots L_{N10+N11}^5$	= List of variable IDs for a “ter” event.

See TABLE I-4 for corresponding variable IDs:

$I_1$	= NPS.
$I_2$	= Event type of the 1 <sup>st</sup> event for this history (see TABLE I-5 ).
$I_3$	= Cell number if cell filtered, otherwise omitted.
$I_4$	= Surface number if surface filtered, otherwise omitted.
$I_5$	= Tally number if tally filtered, otherwise omitted.
$I_6$	= TFC bin tally if tally filtered, otherwise omitted.

**TABLE I-2**  
**PTRAC Input Format**

$m \ n_1 V_1^1 \ V_2^1 \dots \ V_{n1}^1 \quad n_2 V_1^2 \ V_2^2 \dots \ V_{n2}^2 \dots \ n_{13} V_1^{13} \ V_2^{13} \dots \ V_{n13}^{13}$

$m =$  Number of PTRAC keywords = 13

$n_i =$  Number of entries for  $i^{\text{th}}$  keyword or 0 for no entries.

$V_1 \ V_2 \dots \ V_{ni}$  = 1<sup>st</sup> entry, 2<sup>nd</sup> entry, ... for the  $i^{\text{th}}$  keyword (see below).

Index Keyword	Index Keyword	Index Keyword	Index Keyword
1 BUFFER	5 FILTER	9 SURFACE	13 WRITE
2 CELL	6 MAX	10 TALLY	
3 EVENT	7 MENP	11 TYPE	
4 FILE	8 NPS	12 VALUE	

**TABLE I-3**  
**Event Line Variable IDs (See TABLE I-4 )\***

Index	Type 1		Type 2		Type 3		Type 4	
	$(N_{12} \neq 0 \text{ WRITE} = \text{pos})$	$N_{2=5} \ N_{3=3}$	$N_{12} = 0 \text{ WRITE} = \text{pos}$	$N_{2=6} \ N_{3=3}$	$N_{12} \neq 0 \text{ WRITE} = \text{all}$	$N_{2=6} \ N_{3=9}$	$N_{12} = 0 \text{ WRITE} = \text{all}$	$N_{2=7} \ N_{3=9}$
J <sub>1</sub>	7	7	7	7	7	7	7	7
J <sub>2</sub>	8	8	8	8	8	8	8	8
J <sub>3</sub>	9	10,12,10,14	9	10,12,10,14	9	10,12,10,14	9	10,12,10,14
J <sub>4</sub>	17	11,13,11,15	16	11,13,11,15	17	11,13,11,15	16	11,13,11,15
J <sub>5</sub>	18	17	17	16	18	17	17	16
J <sub>6</sub>		18	18	17	19	18	18	17
J <sub>7</sub>				18		19	19	18
J <sub>8</sub>								19
P <sub>1</sub>	20	20	20	20	20	20	20	20
P <sub>2</sub>	21	21	21	21	21	21	21	21
P <sub>3</sub>	22	22	22	22	22	22	22	22
P <sub>4</sub>					23	23	23	23
P <sub>5</sub>					24	24	24	24
P <sub>6</sub>					25	25	25	25
P <sub>7</sub>					26	26	26	26
P <sub>8</sub>					27	27	27	27
P <sub>9</sub>					28	28	28	28

\* For a “bnk” event ( $N_4, N_5$ ), interpret  $J_1 \dots J_4 = 7,8,10,11$

For a “sur” event ( $N_6, N_7$ ), interpret  $J_1 \dots J_4 = 7,8,12,13$

For a “col” event ( $N_8, N_9$ ), interpret  $J_1 \dots J_4 = 7,8,10,11$

For a “ter” event ( $N_{10}, N_{11}$ ), interpret  $J_1 \dots J_4 = 7,8,14,15$

## APPENDIX I

**TABLE I-4**  
**Description of Variable IDs**

Variable ID	MCNP Name	Description
NPS LINE		
1	NPS	See Appendix E
2	—	Event type of 1 <sup>st</sup> event (see TABLE I-5 )
3	NCL(ICL)	See Appendix E
4	NSF(JSU)	See Appendix E
5	JPTAL(1,ITAL)	See Appendix E
6	TAL(JPTAL(7,ITAL))	See Appendix E
EVENT LINE		
7	—	Event type of next event (see TABLE I-5 )
8	NODE	See Appendix E
9	NSR	See Appendix E
10	NXS(2,IEX)	See Appendix E
11	NTYN	Reaction type (see TABLE I-7 )
12	NSF(JSU)	Reaction type (see TABLE I-7 )
13	—	Angle with surface normal (degrees)
14	NTER	Termination type (see TABLE I-7 )
15	—	Branch number for this history
16	IPT	See Appendix E
17	NCL(ICL)	See Appendix E
18	MAT(ICL)	See Appendix E
19	NCP	See Appendix E
20	XXX	See Appendix E
21	YYY	See Appendix E
22	ZZZ	See Appendix E
23	UUU	See Appendix E
24	VVV	See Appendix E
25	WWW	See Appendix E
26	ERG	See Appendix E
27	WGT	See Appendix E
28	TME	See Appendix E

**TABLE I-5**  
**Event Type Description**

Location	Variable ID	Event Type					Flag*
		src	bnk**	sur	col	ter	
J <sub>1</sub>		1000	±(2000+L)	3000	4000	5000	9000

\*When J<sub>1</sub> = 9000, this event is the last event for this history.

\*\*When J<sub>1</sub> < 0, the next event has been rejected and is included for creation information only. The value L is given in TABLE I-6 .

**TABLE I-6**  
**Bank Event Descriptions**

L Value	Description	MCNP Subroutine	NXS & NTYN Provided
1	DXTRAN Track	DXTRAN	Y
2	Energy Split	ERGIMP	N
3	Weight Window Surface Split	WTWNDO	N
4	Weight Window Collision Split	WTWNDO	Y
5	Forced Collision-Uncollided Part	FORCOL	N
6	Importance Split	SURFAC	N
7	Neutron from Neutron (n,xn) (n,f)	COLIDN	Y
8	Photon from Neutron	ACEGAM	Y
9	Photon from Double Fluorescence	COLIDP	Y
10	Photon from Annihilation	COLIDP	N
		ELECTR	
11	Electron from Photoelectric	EMAKER	Y
12	Electron from Compton	EMAKER	Y
13	Electron from Pair Production	EMAKER	Y
14	Auger Electron from Photon/X-ray	EMAKER	Y
15	Positron from Pair Production	EMAKER	N
16	Bremsstrahlung from Electron	TTBR	N
		BREMS	
17	Knock-on Electron	KNOCK	N
18	X-rays from Electron	KXRAY	N
19	Photon from Neutron - Multigroup	MGCOLN	Y
20	Neutron (n,f) - Multigroup	MGCOLN	Y
21	Neutron (n,xn) k- Multigroup	MGCOLN	Y
22	Photo from Photon - Multigroup	MGCOLN	Y
23	Adjoint Weight Split - Multigroup	MGACOL	N

**TABLE I-7**  
**NTER and NTYN Variable Descriptions**

NTER	Description	NTYN	Description
1	Escape	<b>NEUTRON</b>	
2	Energy cutoff	1	Inelastic S( $\alpha, \beta$ )
3	Time cutoff	2	Elastic S( $\alpha, \beta$ )
4	Weight window	-99	Elastic scatter
5	Cell importance	>5	Inelastic scatter (see UKAEA Nuclear Data File)
6	Weight cutoff		
7	Energy importance		
8	DXTRAN		
9	Forced collision		
10	Exponential transform		
<b>NEUTRON</b>		<b>PHOTON</b>	
11	Downscattering	1	Incoherent scatter
12	Capture	2	Coherent scatter
13	Loss to (n,xs)	3	Fluorescence
14	Loss to fission	4	Double fluorescence
<b>PHOTON</b>		5	Pair production
11	Compton scatter		
12	Capture		
13	Pair production		
<b>ELECTRON</b>			
11	Scattering		
12	Bremsstrahlung		

## Appendix J

### Mesh-Based WWINP, WWOUT, and WWONE File Format

The mesh-based weight window input file WWINP and the mesh-based weight window output files WWOUT and WWONE are ASCII files with a common format. The files consist of three blocks. Block 1 contains the header information, energy (or time) group numbers, and basic mesh information. Block 2 contains the mesh geometry. Block 3 contains the energy (or time) group boundaries and lower weight window bounds. Table J.1 presents the file format using generic variables. Table J.2 describes the variables and gives the equivalent variables from the WWINP, WWOUT, and WWONE files.

The  $3 \times 3$  array of fine mesh cells is stored by assigning an index number to each cell. The assignment of mesh cells is illustrated in Fig. J-1. For each value of  $z$  (or  $\theta$ ), all cells are indexed in the  $x$ - $y$  plane (or the  $r$ - $z$  plane). The cell index number is related to the fine mesh number in each coordinate direction through the following formula:

$$\text{cell index number} = 1 + (i - 1) + nfx (j - 1) + nfx \cdot nfy (k - 1),$$

where  $i$ ,  $j$ , and  $k$  are the fine mesh cell numbers along the  $x(r)$ ,  $y(z)$ , and  $z(\theta)$  directions, respectively, and  $nfx$ ,  $nfy$ , and  $nfz$  (by implication) are the total number of fine meshes in the  $x(r)$ ,  $y(z)$ , and  $z(\theta)$  directions, respectively

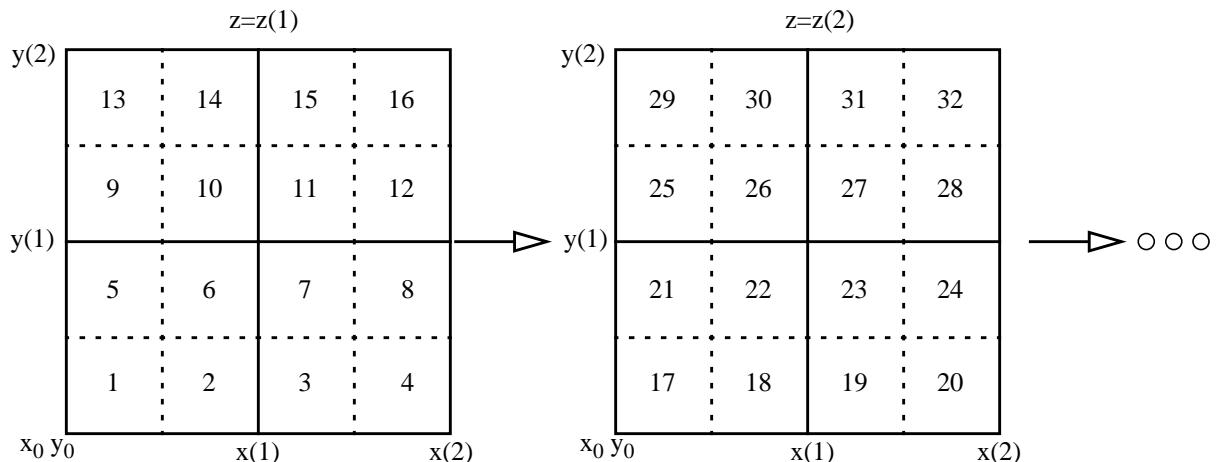


Figure J-1. Superimposed mesh cell indexing

## Appendix J

**TABLE J.1:**  
**Format of the Mesh-Based WWINP, WWOUT and WWONE File**

FORMAT	VARIABLE LIST
BLOCK 1	
4i10	if iv ni nr
7i10	ne(1) ... ne(ni)
	$nr = 10:$
6g13.5	nfx nfy nfz x <sub>0</sub> y <sub>0</sub> z <sub>0</sub>
6g13.5	ncx ncy nc <sub>z</sub> nw <sub>g</sub>
	$nr = 16:$
6g13.5	nfx nfy nfz x <sub>0</sub> y <sub>0</sub> z <sub>0</sub>
6g13.5	ncx ncy nc <sub>z</sub> xmax ymax zmax
6g13.5	x <sub>r</sub> y <sub>r</sub> z <sub>r</sub> nw <sub>g</sub>
BLOCK 2	
	$nwg = 1:$
6g13.5	x <sub>0</sub> nfm <sub>x</sub> (1) x(1) rx(1) nfm <sub>x</sub> (2) x(2)
6g13.5	rx(2) ... nfm <sub>x</sub> (nc <sub>x</sub> ) x(nc <sub>x</sub> ) rx(nc <sub>x</sub> )
6g13.5	y <sub>0</sub> nfm <sub>y</sub> (1) y(1) ry(1) nfm <sub>y</sub> (2) y(2)
6g13.5	ry(2) ... nfm <sub>y</sub> (nc <sub>y</sub> ) y(nc <sub>y</sub> ) ry(nc <sub>y</sub> )
6g13.5	z <sub>0</sub> nfm <sub>z</sub> (1) z(1) rz(1) nfm <sub>z</sub> (2) z(2)
6g13.5	rz(2) ... nfm <sub>z</sub> (nc <sub>z</sub> ) z(nc <sub>z</sub> ) rz(nc <sub>z</sub> )
	$nwg = 2$
6g13.5	r <sub>0</sub> nfm <sub>r</sub> (1) r(1) rr(1) nfm <sub>r</sub> (2) r(2)
6g13.5	rr(2) ... nfm <sub>r</sub> (nc <sub>x</sub> ) r(nc <sub>x</sub> ) rr(nc <sub>x</sub> )
6g13.5	z <sub>0</sub> nfm <sub>z</sub> (1) z(1) rz(1) nfm <sub>z</sub> (2) z(2)
6g13.5	rz(2) ... nfm <sub>z</sub> (nc <sub>y</sub> ) z(nc <sub>y</sub> ) rz(nc <sub>y</sub> )
6g13.5	$\theta_0$ nfm <sub><math>\theta</math></sub> (1) $\theta$ (1) r $\theta$ (1) nfm <sub><math>\theta</math></sub> (2) $\theta$ (2)
6g13.5	r $\theta$ (2) ... nfm <sub><math>\theta</math></sub> (nc <sub>z</sub> ) $\theta$ (nc <sub>z</sub> ) r $\theta$ (nc <sub>z</sub> )
BLOCK 3	
	<i>Particle i, i=1,ni</i>
6g13.5	e(i,1) ... e(i,ne(i))
	<i>Energy (or time) group j, j=1,ne(i)</i>
6g13.5	w(i,j,1) ... w(i,j,nwm)

**TABLE J.2:**  
**Explanations of Variables from Table J.1**

VARIABLE	WWINP	WWOUT	WWONE
if	File type. Only 1 is supported.		
iv	Unused		
ni	Number of integers on card 2		
nr	Number of parameters from nfx through nwg at the end of Block 1. nr = 10 / 16 for rectangular/ cylindrical mesh		
ne(i)	NWW(i)	NGWW(i)	1 for each i for which NGWW(i) ≠ 0
nf[x,y,z]	WWM(1-3)	WWMA(1-3)	
x <sub>0</sub> , y <sub>0</sub> , z <sub>0</sub>	WWM(4-6)	WWMA(4-6)	
nc[x,y,z]	WWM(7-9)	WWMA(7-9)	
[x,y,z]max	WWM(10-12)	WWMA(10-12)	
xr, yr, zr	WWM(13-15)	WWMA(13-15)	
nwg	NWGEOM	NWGEAO	
nfm[x,y,z / r,z,θ](i)	WGM(*)	WGMA(*) Number of fine mesh cells in coarse mesh cell i in x,y,z / r,z,θ directions	
[x,y,z / r,z,θ](i)	WGM(*)	WGMA(*) Upper coordinate of coarse mesh cell i in x,y,z / r,z,θ directions	
r[x,y,z / r,z,θ](i)	WGM(*)	WGMA(*) Fine mesh ratio in coarse mesh cell i in x,y,z / r,z,θ directions. Currently only 1. is supported.	
r <sub>0</sub> , z <sub>0</sub> , θ <sub>0</sub>	Origin of the radial, axial, and azimuthal directions; must be 0., 0., 0.		
e(i,j)	WWE(*)	EWWG(*)	Default maximum jth upper energy (or time) bound for particle type i
w(i,j,k)	WWF(*)	Weight window generator output Lower weight window bound for particle i, energy (or time) group j, and fine mesh cell k	
nwm	NWWM	NWWMA	

## **Appendix J**